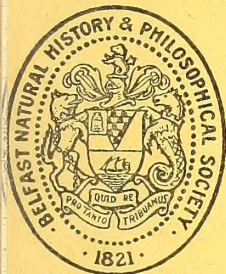




22 JUL 1949

BELFAST NATURAL HISTORY
AND
PHILOSOPHICAL SOCIETY

126TH SESSION



PROCEEDINGS
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SESSION
1946 - 1947

SECOND SERIES
Volume 3, Part 2.

PRICE : : : TWO SHILLINGS

PROCEEDINGS and REPORTS



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BELFAST NATURAL HISTORY AND PHILOSOPHICAL SOCIETY

Second Series Vol. 3, Part 2.
126th SESSION, 1946 - 1947

BELFAST :
PRINTED BY THE NORTHERN WHIG, LTD., BRIDGE STREET.

1948.

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RECENT RESEARCHES ON THE FLORA AND FAUNA OF THE WESTERN ISLES OF SCOTLAND AND THEIR BIOGEOGRAPHICAL SIGNIFICANCE.

J. HESLOP HARRISON, M.Sc.

Plates I and II.

In selecting this topic for my talk this evening, I have been guided by a belief that, as students of the Natural History of Ireland, members of the Society will be interested to hear something of an area of Britain which possesses so much in common in scenery, culture, climate, wild life and even in history. For the biologist, the problems presented by the flora and fauna of the Hebrides are remarkably similar to those of Ireland, and any new facts which contribute to the understanding of one group of problems must necessarily help in resolving the other. I hope this point will become clearer as I proceed, although to-night I will have time only to touch on the subject, and merely to outline some of the results of the work which the various expeditions from the Biological Departments of King's College, University of Durham, have been conducting in the Western Isles during the last twelve years.

The Hebrides form interesting territory for the field biologist. Because of their isolation, climate and unpromising topography, they have avoided the "civilising" influences of industry and large scale agriculture. They have even, despite the perseverance of the breed, long resisted the serious attentions of naturalists. In comparison, the Scottish mainland has been well "worked" by the biologist, and it is not surprising that an abundance of new facts has come to light during work in the islands during the last two decades. In fact, the Western Isles have betrayed an unsuspected richness of flora and fauna, and the gradual revelation of unusual patterns of distribution, even in relatively common plants and animals, has made it clear that they have much to contribute towards the solution of some of the problems connected with the history and origin of the British biota.

Before considering these, some general account of the Hebrides and of their cultural background may not be out of place.

The Hebridean climate, generally speaking, is of the extreme oceanic type. The highest rainfall occurs in the larger islands of the inner group, Skye and Mull, which are in so close contact with the mainland as to form, biologically, a unit with it. Elsewhere, annual rainfall is of the order of 40-60 ins.: not an excessive figure in comparison with that of much of the Western Highlands. Nevertheless, the seasonal distribution of rain is such that the number of "rain days" (days upon which more than 0.01 ins. of rain falls) per annum is high, particularly in the northern islands, North Uist, Harris and Lewis. On the latter island, the number exceeds 260 per annum. These observations give, as nearly as existing meteorological methods allow, an index of the humidity of the Western Isles. The almost constant stream of saturated air which pours over the islands with the prevailing winds, the effect of which is only partly recorded by the rain gauge, has important repercussions on the vegetational complexes.

Also associated with the oceanic situation is the low annual *range* of temperature; Stornoway, Lewis, for example, with a mean annual temperature between 46 and 47°F., shows a summer to winter variation about this figure of less than 8°. Again this is highly significant biologically, for here, in a climate practically frost-free, southern species are able to flourish in much the same manner as *Arbutus unedo* and the other famous plants of the Lusitanian element do in the south-west of Ireland.

However, *wind* is undoubtedly the great limiting climatic factor in the islands. Unprotected from the south-west, they receive the full velocity of the Atlantic gales, which exert a relentless suppressing effect on the higher vegetation, and prohibit the growth of continuous tree cover. Notwithstanding this fact, even the Outer Islands do possess their miniature woodlands, in sheltered gorges and on cliff faces, hidden from casual view. It is not surprising that popular opinion has it that the islands are entirely tree-less: inhabitants of South Uist expressed astonishment on being shown hazel nuts ripened on their own island!

For the archaeologist the islands are rich in interest. Evidence of continuous inhabitation since Neolithic times is widespread. In the dune sands, on the "machair" (machair is the name applied to the stabilised zone behind the dunes, where calcareous sand has neutralised moorland peat and produced rich grazing land) and in caves above sea level, kitchen middens await critical excavation on almost every island. An example on the uninhabited island of Sandray, exposed by wind action, reveals a face no less than nine feet deep of shells and miscellaneous debris.

Larger monuments of later times have survived: stone circles, such as the magnificent example at Callernish on Lewis, barps, chambered cairns, and perhaps most striking, the innumerable duns and brochs. Perhaps initiated during the Bronze Age, some of these have been used by diverse occupants until comparatively recent times. In the Outer Isles duns are to be found in practically every loch, connected by their winding or semi-submerged causeways to the shore. Viking rule left its mark in iron ornaments, weapons and rivets of the square-headed boat type which appear in dune blow-outs as the wind exposes sites of occupation or burial. The passing of Viking rule in the thirteenth century was succeeded by the Lordship of the Isles and the so-called "clan" period, with its grim and entangled history of minor warfare; again the signature remains in stone—castles, fortifications and harbour works.

The modern inhabitants of the Outer Isles pursue a somewhat more primitive existence than their more sophisticated brethren in the Inner Hebrides. Wireless, motor-driven fishing craft and subsidised houses have brought some change in ways of life, and recent world events have helped to broaden some horizons. Yet in the remoter parts of the Outer Isles the primitive crofting, fishing and weaving economy persists, and one may still find the "black house," with peat smoke billowing out of the tiny windows from the open fire in the centre of the floor. If he speaks English at all, the inhabitant will probably tell you that it is "good for the midges"! On many of the islands, "lazy-bed" agriculture remains the sole effective method of producing crops on the intractable gneiss, and in the lazy-beds one may still find the Bristle Pointed Oat, *Avena strigosa*. Surely this is its last stronghold in Britain!

In attempting a brief survey of the natural history of these wonderful isles, I am faced with the problem of selecting and compressing data. Much of the barrenness observed by the casual visitor is but superficial, and many islands show remarkable ecological diversity. Thus the Isle of Rhum, the profile of which is seen so strikingly down the glens from the Fort William—Mallaig railway, supports more than 650 species of vascular plants within its fifty square

miles. Geologically Rhum is extremely varied. Torridonian sandstones and shales form the quiet rounded landscapes of the north and east, while the higher hills of the southern half of the island are composed of complex intrusive igneous rocks of Tertiary origin. Correspondingly the scenery is varied, although everywhere dominated by the impressive massif of the south-east, which forms the most extensive mountain system in the Western Isles outside of Skye. The more inaccessible cliffs are among the few remaining nesting places of the eagle in the islands, and on most of the higher hills are to be found the burrows of the Manx Shearwater. Rhum supports a large deer population, and has a unique herd of wild ponies, of ancient origin. The most elusive of the larger wild life are the goats, which seem to spend their time mostly on the slopes of Bloodstone Hill and Sgurr nan Gilleann, and often are detected by their scent alone!

Botanical interest centres mainly upon the floras of the higher mountains and cliffs, and upon the remarkable relict woodland floras which persist in gorges and on the lower east- or north-facing cliffs. *Saxifraga oppositifolia*, *S. hypnoides*, *S. stellaris*, *Saussurea alpina*, *Silene acaulis*, *Oxyria digyna*, *Arabis petraea*, *Thalictrum alpinum*, *Deschampsia alpina* and many of the other commoner alpine plants are well distributed on the Askeval-Hallival massif. On the hills to the south, along the ridge which links Ruinsival and Sgurr nan Gilleann is the Norwegian Sandwort, *Arenaria norvegica*, known elsewhere in Britain only from Shetland. On these hills also grow the Parsley Fern, *Cryptogramme crispa*, and the Green-ribbed Spleenwort, *Asplenium viride*. Bloodstone Hill, Orval, and Fionchra in the west of the island support such unusual plants as the Alpine Penny Cress, *Thlaspi calaminare*, *Saxifraga nivalis*, *Salix myrsinites*, *Poa alpina*, and the Pyramidal Bugle, *Ajuga pyramidalis*. The small areas of limestone to the north of these hills provides a habitat for the Mountain Avens, *Dryas octopetala* and *Saxifraga aizoides*, the Yellow Mountain Saxifrage.

The larger areas of woodland on the island nowadays are all artificial. Native woodland exists in the gorges and on cliff faces; in such sheltered habitats well-grown hollies, aspens, birches, willows, roses and even oaks are to be found. Many carry their complements of native insects, further evidence of their indigenous character. The associated woodland flora flourishes in the gorges, often in the absence of trees. *Oxalis acetosella*, *Teucrium Scorodonia*, *Scilla non-scripta*, *Allium ursinum*, *Ajuga reptans*, *Vicia sylvatica*, *Equisetum sylvaticum* and *Sanicula europaea* are all, typically, gorge- or cliff-living species, as well as *Hymenophyllum peltatum* and *Phyllitis Scolopendrium*.

The Outer Isles are a great deal less varied in geological structure than the Inner, and are composed throughout their one hundred and thirty mile length mainly of the ancient gneisses and other rocks of the Archaean complex, with occasional basaltic intrusions and extrusions of Tertiary origin in the form of dykes and lava flows. In general the higher ground tends to be in the east, where the land descends precipitously to the sea; the western shores are composed of great linked series of brilliant white shell sand beaches, backed by machair. Here summer brings a vast and colourful profusion of flowering plants: clovers, vetches, storksills, bedstraws, gentians, eyebrights, geraniums and many alkaliphilous species. One of the most striking plants of machair areas in the southern islands is the Hebridean version of the Spotted Orchid, *Orchis Fuchsii* var. *hebridensis*, the deep colour of which actually tints the landscape on some islands. Prince Charlie's Flower, growing in the bay named after him on the Isle of Eriskay, proved to be the Sea Convolvulus, *Calystegia Soldanella*. More unusual, if somewhat less spectacular, are some of the machair sedges and rushes, including *Carex incurva* and *Juncus balticus*. The machair also is the home of the characteristic bee, *Bombus smithianus*.

Between the machair and the eastern hills lies the area of moorland, loch and bog, beloved of the fishing visitor. Unusual plants favouring these areas include the Bog Orchid, *Malaxis paludosa*, the Western Butterwort, *Pinguicula lusitanica*, all three Sundews, the Twayblade, *Listera cordata*, and the Bog Pimpernel, *Anagallis tenella*. In the lochs grow a plant of American affinities, *Najas flexilis*, and the western Water-lily, *Nymphaea occidentalis*, as well as many unusual species and hybrid forms of the genus *Potamogeton*.

The most extensive mountain floras are to be found in the hills of Harris and South Uist, although many of the montane species stray down to sea level in Lewis and elsewhere. *Salix herbacea*, *Poa alpina*, *Cochlearia alpina*, *Saussurea alpina*, *Deschampsia alpina* and many of the Saxifrages are among the oddities.

Perhaps in reaction against the popular ideas of the barrenness and desolation of the Western Isles, one tends to emphasise excessively the unusual in a survey of this nature. In all truth, the major plant formations of the Outer Isles are not at all inspiring: the climatic conditions of to-day favour the development of that most depressing type of British vegetation, blanket bog. Blanket bog, impoverished in species, practically useless in agriculture and most tedious to traverse, covers the greater part of such islands as Lewis, where the topography is such as to impede rapid water run-off and thus to encourage the growth of Sphagnum. In areas of more rapid water loss, this formation passes into heather moor, somewhat richer in species, but almost as monotonous in its structure. The interesting communities of plants are almost all confined to somewhat specialised habitats: to machair zones, where calcareous dune sand, composed largely of comminuted shell fragments, has raised the pH and favoured the growth of less acid-tolerant forms; to mountain summits and screes, and to cliffs, gorges and ravines where protection from wind and grazing has allowed the persistence of many species. These latter habitats are of the nature of refuges, and many of their occupants are to be regarded as relicts. Relicts, then, from what better times?

In a great many cases the answer lies sunken in the peat of the bog itself, for the occurrence of woodland remains in the peat is familiar to any peat cutter in the islands. The present climatic conditions, the onset of which brought about the spread of Sphagnum and the destruction of the Sub-Boreal woodlands, were initiated perhaps 700 years B.C., at the opening of the so-called Sub-Atlantic period. To this climatic deterioration rather than to any destructive activities of the Norsemen is to be attributed the extinction of large woodlands in the Hebrides. Deprived of tree cover and exposed to a new colder and damper climate many woodland species found refuge on cliffs and in gorges. And thus we come to have, on desolate little islands like Scarp, cliff floras including *Oralis acetosella*, *Scilla non-scripta*, *Equisetum sylvaticum*, *Vicia sylvatica* and the like.

Movements such as these are comparatively recent phenomena. In attempting to find explanations for the distribution of many of the most unusual Hebridean species, we must go back a great deal further in time, and are brought face to face with a problem which has exercised the minds of Irish biologists for a great many years now—that of the fate of the north-western European plants and animals during the Pleistocene glaciations.

In approaching the problem we must establish some datum, and that logically is the close of the Tertiary period. In Pliocene times there is good evidence that the climate and vegetation of the British Isles were very much as they are to-day. The presence of the pre-glacial raised beaches discovered by W. B. Wright on Colonsay, and on the islands west of Mull, leaves little doubt that the Hebrides were islands at that time. In Pleistocene times came the great succession of glacial periods, three or possibly four of which can be recognised

in the British Isles. Separated by long interglacials, of which the longest, the penultimate, may have lasted as long as quarter of a million years, these glacial periods were punctuated by interstadials, when no doubt as a result of a temporary climatic change the ice was checked and locally retreated.

The main picture of the course of events in the Scottish Western Isles is fairly clear. The great ice-sheets formed in the Highlands, which flowed eastwards until they met the advancing Scandinavian ice, south into England and south-west until they were deflected by Irish ice, can have met with little check as they advanced across the Minch, eventually to be dissipated in icebergs when they approached the edge of the continental shelf. The evidence of ice passage is present on every hand in the Western Isles, in the polished and rounded landscapes, striae, erratics and *roches moutonnées*. It is an unusual and perhaps significant fact that boulder clay, the familiar legacy of the ice in many parts of Britain, is not widespread in the Hebrides; for over wide areas, particularly to the west of the hills in the Outer Isles, drift is poorly developed.

With such a picture of relentless exterminating forces in mind, it is not too surprising that a great many geologists regard the possibility of the survival of life within the glaciated zone as somewhat slender!

Before approaching the biological evidence, two further results of glaciation must be considered. Although the climatic causes of initial ice accumulation remain obscure, it is possible to gather some idea of the effect of ice upon local climates, once the sheet has been established, from the evidence of existing ice-caps. Since a large ice-sheet functions as a reflector in re-radiating a large component of solar heat, it tends to resist heating up; further, by virtue of its cooling effect upon the air it eventually comes to control its own weather and that of peripheral regions, setting up a permanent anti-cyclone and becoming the source of continuous radially directed winds. The second indirect effect, that on the relative levels of land and sea, is of great importance in studying the fate of an archipelago bordering an ice-sheet of continental dimensions. The enormous abstraction of water from the sea involved in the development simultaneously in various parts of the world of ice-caps which may have been as thick as 10,000 feet in their central regions must have led to universal lowering of sea-levels. Such an effect is termed eustatic. Another factor controlling relative land and sea levels in the immediate neighbourhood of the cap is now believed to have been superimposed, that brought about by the depression of the earth's crust by the ice-load. Displaced sub-crustal magma from the region beneath the ice flowed towards the periphery and there relieved its pressure by displacing upward the un-loaded crust: an effect known as isostatic. The result may have been a "bulge" of land surface displaced some distance from the ice-front, but moving with it during advance and retreat. Such a concept plays an important part in biological theory, and is not without its geological support.

Acceptance of the thesis of total extermination of the biota within the limits of the ice-sheet implies that at the commencement of each interglacial period, and during and after the valley glaciation which brought to an end the last glacial phase and ushered in modern times, great migrations of plants and animals took place, re-populating the newly released territory from sources south of the former limits of the ice-cap. In the case of Britain, that is, mainly from continental sources across the post-glacial land bridge. The British flora and fauna should thus be an impoverished version of the continental, and that of the islands west of Great Britain, an impoverished version of the British. In general that is true, but as the student of Irish Natural History is aware more than most others, *not in its entirety*.

The distribution of three groups of species in the Hebrides cannot be reconciled with the thesis of a post-glacial continental origin *via* Great Britain. These coincide in affinities with those long recognised as anomalous in the Irish biota. They may be loosely termed the boreal and alpine, the southern and south-western and the American elements.

I have already mentioned outstanding Hebridean plants of arctic-alpine affinities, *Arenaria norvegica*, *Poa alpina*, *Deschampsia alpina*, *Ajuga pyramidalis* and the like. It is interesting to note that certain species, normally regarded as of montane proclivities, occur at sea-level in the Outer Isles, for example, *Silene acaulis* and *Polygonum viviparum*. The paradox of sea-level "alpines" again is familiar enough to the Irish botanist.

At least a component of this group, including those forms not known outside the glacial area, can only be considered to have "overwintered" within its periphery. Scandinavian botanists (in particular I would mention Nordhagen) have reached similar conclusions dealing with a similar group, including many identical species, with an anomalous distribution in the Scandinavian peninsula. It seems likely that these plants persisted in ice-free refuges within the glaciated area. In attempting to fix such survival centres geographically the plants themselves give many pointers since many of them seem static, and do not now give evidence of much power of migration. Thus we find the Beinn Mhor massif on South Uist a focus for fourteen probable relict species, and we might safely conclude that their refuge was not far removed. Possible models for such refuges are to be found within the periphery of modern ice-sheets, in the so-called "nunataks," ice-free mountain summits and cliff faces. A flora of a small Icelandic nunatak, listed by Anderson in 1937, includes such species as *Saxifraga oppositifolia*, *S. hypnoides*, *S. nivalis*, *Silene acaulis*, *Poa alpina* and *Salix herbacea*. It is notable that a list like this agrees, even to the inclusion of identical species, with what one might have postulated for a survival group in the Western Isles. The fact that climatic conditions are not so extreme as to prohibit sustained growth is highly significant. Clearly refuges of such a nature cannot have existed on any Scottish mountains had the ice-cap been as thick there as it has been suggested it was towards its foci. Marginally there is good reason to believe that the thickness of the cap fell very considerably, and geologists, such as Jehu and Craig, who have studied the Western Isles, admit the possibility that even at the height of the last glaciation the mountains were not entirely over-ridden, relatively low although they may be. In proposing a history of survival for such a group, complete survival from Pliocene times it not necessarily implied. One must not lose sight of the opportunities provided for re-colonisation during the protracted inter-glacial periods, and it is perhaps the remnant of a formerly continuous flora of the last interglacial, or even of the Aurignacian interstadial, with which we are dealing.

In a different category is the group of species known as the American element. *Eriocaulon septangulare*, the Pipewort, long known from the west of Ireland and from a Skye station, abounds in several lochs on the Isle of Coll. In 1939 I had the good fortune to find the Irish Ladies' Tresses Orchid, *Spiranthes stricta*, the pride of the flora of the North-East of Ireland, also on the Isle of Coll. This locality is one of the two extra-Hibernian stations known for the plant in Europe, the other being on the island of Colonsay, in the southern-most of the Inner Hebrides. I visited Colonsay in 1940 in search of the plant. The remains of the fence which had guarded the last known colony were still visible, but not

the plant itself. We cannot, however, conclude that it is now extinct there, for *Spiranthes* is a notably erratic flowerer, and 1940 may have been a dormant year.

Yet others of the Irish-American group continue to come to light in the Hebrides. *Najas flexilis*, the Slender Naiad, proves to have quite a considerable range, as does the sponge, *Heteromyenia ryderi*. Forty years ago a distinguished Irish geologist, Dr. Scharff, pointed out the difficulties of explaining the distribution of this group in Ireland on the basis of any theory of post-glacial migration from continental sources. Theories of random distribution from North American sources are as untenable. I need not go into the details of the reasons which have brought modern phytogeographers to reject hypotheses of long-distance chance dispersal in favour of methods of slow progress over continuous land surfaces in explaining plant migration. I would merely wish to emphasise one less obvious factor, which has special application to a group in which I have a particular interest—the orchids. For healthy growth, and even, in some cases for germination of the seed, many orchids demand the presence of a symbiotic fungus in the soil. To explain the establishment and spread of an orchid species in a remote new area, one has to postulate the existence there in advance of a seed-bed complete with living strains of the appropriate fungus!

To find a suitable date of arrival of these North American species, and for that matter for the arrival of the corresponding European element in North America, for such exists, we have to go back to Tertiary times. The corollary is then that this element, at least, must have endured the entire Pleistocene in western Europe, and furthermore, in view of its complete absence to-day outside of the glaciated zone, either within the ice-sheet, or on marginal land now submerged. The recent discovery of *Eriocaulon* in inter-glacial beds in the West of Ireland gives material support to such a view. Even if we adopt the somewhat less probable alternative hypothesis relating to these species proposed by the Scandinavian botanist, Hultén, that is, that they formerly occupied a complete circum-polar belt extending from eastern American, through Alaska, across the Bering Sea, through Siberia and into Europe and have subsequently been extinguished throughout the entire intervening area by the glaciation, we are left with the fact of their survival at the extremes of their range.

Before considering a possible locus of survival of these species, I must mention briefly the groups of plants and animals of southern proclivities which have anomalous ranges. Yet again, the Irish examples are too well known to require recapitulation. Parallel Hebridean forms are *Trifolium Bocconi* on Coll, *Rubus iricus* in the Outer Isles and so forth. In the Hebrides we have an unusual example in the form of a moss—*Myurium hebridarum*. This plant is by no means rare on Rhum, Coll, Tiree and practically throughout the Outer Islands. Outside the Hebrides, its range is restricted to the Canary Isles, Madeira and the Azores. As it fails to fruit, reproduction is purely vegetative, and therefore again, long range random dispersal cannot be called in to account for its distributional pattern. Here too must be mentioned the endemic races, and such forms as the bee, *Bombus smithianus*, and the Belted Beauty moth, *Nyssia zonaria** (which possesses a wingless female, and is thus anchored to the islands of its occurrence); the Hebridean field-mouse, *Apodemus hebridensis*, and others.

*In an address to this Society (published in the "Reports and Proceedings, Session 1929-30") the Rev. Canon Foster, M.A., gave an interesting account of the distribution of this, and many other of the insects I have mentioned, in Ireland. His address included a summary of the early views of my father, Prof. J. W. Heslop Harrison, D.Sc., F.R.S., on the distributional history of *Nyssia zonaria*.

With the American element, many of these must represent the descendants of very ancient survivals. But again, like the American element, they are hardly organisms which might be expected to have persisted on nunataks within the ice-sheet, subject to a rigorous frost climate and probably at a considerable altitude, although it is perhaps significant that *Myurium* is often found to accompany the groups of arctic and alpine species of relict nature. It should also be made clear that the post-glacial submergences and emergences which progressively altered the configuration of the Hebrides as a result of the interplay of isostatic and eustatic effects, whatever their exact sequence may prove to be, most certainly had the effect of submerging many of the land areas now occupied by these species. The low-lying land of Coll, for example, the present focus for the American element in the Hebrides, cannot be supposed to have been the home of these species continuously throughout post-glacial times.

To this extent then, the species of these elements are post-glacial migrants, and their glacial refuge must be sought elsewhere. Here, again, we come back to the isostatic peripheral "bulge" which I have previously mentioned. Unglaciaded land to the west of Ireland and the Hebrides, now submerged, has long been proposed as a glacial home for the anomalous species. The romantic might identify it with the legendary Tir nan Og; in face of geological opposition and the proximity of the edge of the continental shelf, even the most enthusiastic of biological survivalists can only suppose that it took the form of a low and narrow belt. Nevertheless, did it exist, we can make some deductions regarding the conditions it offered for life. Across it, and probably dissecting it into isolated areas in the ice "shadows" of the mountains, must have passed the dissipating streamers of ice from the vast ice sheets to the east. As to its ability to support life, we have only to look at the ice-free coastal zones of Greenland to see how extensive plant and animal communities may be in such pockets. Then again, it has been proposed that the actual causes of the glaciations involved an increase in oceanicity of the climate—the theory of Sir George Simpson actually postulates two successive phases of *increase* in solar radiation as causes of ice accumulation. The climate of marginal zones bordering on the Atlantic may therefore, even during the height of cap development, have been a great deal milder than is popularly supposed.

Of course, in research of this nature, stress must inevitably be placed upon the anomalous species, and on many which are rare. This does not, of course, imply that the commoner species may not have their representatives in the refugia, but merely that in subsequent times, these have merged with the torrent of re-colonising plants and animals which poured into the ice-free areas over post-glacial land bridges, and so have lost their identity. Nevertheless, when species are subjected to refined taxonomic analyses, there is often evidence of the survival of commoner forms. Here we meet another interesting phase of recent work, that which bears upon the micro-evolutionary changes which have taken place since the close of Tertiary times.

Organisms surviving in the western strip would be isolated genetically from the main European stocks, at least during part of the last glaciation. Evidence of racial divergence is coming to light in a great many species, and a whole group of varieties and forms of common species with the so-called "fringing" pattern of distribution are now known. The variety *procumbens* of *Hypericum pulchrum*, the Beautiful St. John's-wort, is a well-marked case in point. This is known from the Faroes, Shetland, Outer Hebrides, and has

been recorded by Dr. Praeger from Clare Island in the west of Ireland. It is unknown elsewhere. Similarly the fleshy-leaved form of the common Honey-suckle, var. *Clarkii*, possesses a fringing Hebridean range. Then the marsh orchids of the West of Ireland have recently been recognised as distinctive forms absent from Britain. *Orchis majalis*, subspecies *occidentalis*, recently segregated by Mr. Pugsley, has proved to have an Outer Hebridean range. Apart from those already mentioned, many insects have differentiated island and western races, many of these once more common to Ireland and the Western Isles. The Meadow Brown, the Grayling and the Common Blue are butterflies which provide examples.

Even where taxonomic research has as yet failed to demonstrate morphological differences, it is frequently possible to deduce racial distinction from the habits of the indigenous representatives of common species. Thus the Common Willow-herb, *Epilobium angustifolium*, is undoubtedly present in two strains in Britain. The aggressive "Blitzweed" of London bombed sites, familiar to us as a coloniser of waste-places, forms one strain. The other is the plant of which Dr. Praeger says: "In Ireland, as a native, a rather rare mountain plant." In the Hebrides, I may add, the same statement is fully applicable. On Rhum, for example, one has to scale the almost vertical cliffs of Bloodstone Hill and then use binoculars to glimpse the plant. *Juncus tenuis* is a further example. A somewhat conservative plant of strictly natural habitats in Kerry, it is an aggressive coloniser of pathways and waste-places in Britain generally. The common Red Campion, *Lychnis dioica*, seems also to have a stagnant relict race confined to cliffs and similar habitats in the Hebrides.

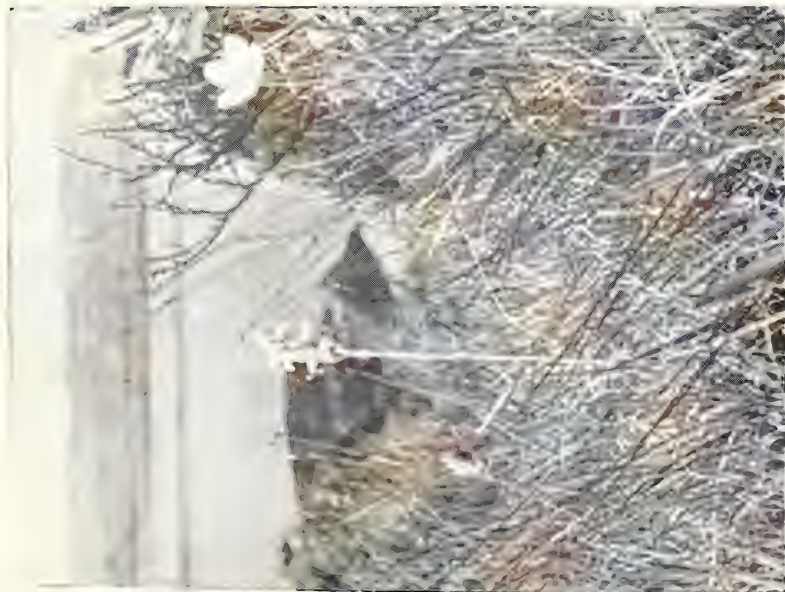
Recent eco-taxonomic research gives us a clue to the meaning of these mysterious habit differences between "rigid" and "plastic" races of the same plant species. Any wild species is composed of an assemblage of biotypes, each differing in some minor physiological manner from the others. The composite genetical make-up of the species as a whole lends plasticity; the species has a reserve of pre-adaptive characters which allows it to meet and overcome minor checks to its expansion, and thus to occupy a diversity of habitats within, of course, the species-range. Our modern aggressive "Blitz-weed" is undoubtedly a biotype-rich, and thus plastic, species, and so probably was the fraction of the species which was isolated in the western refuges at the commencement of the last glacial phase. With the vicissitudes of life there, elimination of unsuitable biotypes ensued, and that component of the species which emerged from its long isolation was biotype-poor in comparison with the component which had passed the glacial period in the freer conditions of ice-free southern Europe. Biotype-impoverished, the resultant rigid race expresses its lack of flexibility and colonising power in adhering century after century to its original habitats, where possibly conditions most nearly approach those of its former glacial refuges.

The next phase in the analysis of the evolutionary phenomena of physiological and morphological race differentiation such as I have outlined will no doubt be experimental, utilising the techniques of the laboratory geneticist and cytologist. We already have evidence pointing to cytological dissimilarities in races of presumed relict character in certain species.

I have previously mentioned in passing something of the late post-glacial history of the vegetation of the Western Isles. In this connection, I would recall

an important modern technique of investigation which will be known to many: that of pollen analysis. The work has begun in the islands of applying the method of statistical analysis of sub-fossil pollen grains preserved in the strata of peat-bogs, a technique which, brilliantly developed in the Scandinavian countries, has provided a complete and vivid record of post-glacial climatic changes there as reflected in the resultant alterations in forest composition. Time forbids a detailed account, but it may be said in general that the pollen-story of the Western Isles correlates well with that derived from Irish peat deposits, and can be dove-tailed into the generalised European picture. In addition, peat borings in the Hebrides promise to provide evidence from which a detailed picture may one day be synthesised of the post-glacial movements of relative land and sea level, a knowledge of which will undoubtedly assist in clarifying yet further the history of the biota.

In concluding this brief survey of recent work in the Western Isles I should like to make one or two general comments. I hope you will agree with me that, far from being an exhausted subject of investigation, biological field-work in the British Isles is actually entering into a new phase of productive activity. The field is one in which critical and detailed ecological, taxonomic and genetical observation alone will suffice, but it is also one from which may be expected a wealth of new facts. The goal is not merely the understanding of the structure of the native plant and animal communities as they are, but also the synthesis of the complex tale of their history and origin.



The Irish Ladines: Truus - O'ellid, *Sparganium angustifolium*, near Loch Criad, Isle of Coll. This Hebridean station is the only one for the plant in Europe, outside of Ireland.



The North American Pipewort in Loch a Mhill Aird, Isle of Coll. A plant of the *American* *known only in Europe* from Ireland, Skye and Coll.



A tuft of the moss *Myurium hebridarium* on the Isle of Barra. Restricted to the Hebrides in Britain, the other stations for this moss are the Canary Islands, Madeira and the Azores.



Lupinus pyramidalis (L.V.), the Pyramidal Bugle, a rare mountain plant of northern-most Scotland, growing at an altitude of 150 ft. on the Isle of Coll.

Photos J. Heslop Harrison.

11th February, 1947.

MR. F. J. COLE, President, in the Chair.

"GOYA: THE SIGNIFICANCE OF HIS ART."

PROFESSOR I. GONZÁLEZ LLUBERA, M.A., D.Litt.

Abstract.

The lecture was prefaced by a brief outline of the artist's biography: his early training in the provincial environment of mid eighteenth century Saragossa and his introduction to Madrid artistic circles; his stay in Italy and return and rapid success at the Spanish Court; the effects of his deafness on the work of the middle and later periods; his conduct—a curious mixture of opportunism and patriotism—during the French occupation and the reactionary rule of Ferdinand VII after the Peninsular War; his last years and death in voluntary exile at Bordeaux.

The lecture intended to show that eighteenth century technique and aims do not explain Goya's art, which became increasingly personal and individualistic after the works of his early period. Goya, of course, starts from the practice of his times—he is a contemporary of Mengs, David, Canova—but he also shows some points in common with the genius of Beethoven. He soon outstrips eighteenth century experience and his manner and subjects often intend to convey ideas and trends which are those of the nineteenth century: local colour, liberalism, scepticism. His subjects and technique are animated by a potent, often wild dynamism, and a peculiar acid humour. His temperament leads to experiment on the expressive possibilities of etching and engraving. He soon mastered and became supreme in both.

Professor Llubera illustrated the evolution of Goya's art with reference to his portraits and commented with some detail on *The Family of Charles IV*. The preponderant role of the Madrid environment in Goya's work was illustrated in the light of the designs for the Royal Tapestries, the war scenes in the Prado Museum, some examples from the collections of etchings and engravings—the *Caprichos*, the *Proverbios*, *The Desastres de la Guerra*, and the *Tauromaquias*—and the late paintings. The portrait of Don Francisco Muguero, one of the latest, if not the latest, of Goya's works was described as a landmark in the history of modern painting and a clear precedent of Manet's technique.

Goya's art ranges between the extremes of evasion and escapism and stark realism. A realism which includes ugliness, human misery, the macabre, but ought not to be interpreted as aiming at objectivity. Goya's method of presentation may be described as a transposition, upwards or downwards, of reality. It always tends and often resolves itself into deformations of reality. In this manner Goya, the visionary joins Goya, the realist. Goya, unlike Blake, was never dominated by his visions. His performance is never spectacular. His artistic technique responds to his temperament. His art expresses in various ways the ideology of the French revolution and represents the incorporation of Spain to European liberalism. It is not incongruous that the artist spent his last years in the country from which emerged the Declaration of the Rights of Man.

Thursday, 21st November, 1946.

MR. F. J. COLE, President, in the Chair.

“ASTRONOMY AND THE AMATEUR.”

Illustrated by Slides.

E. M. LINDSAY, M.Sc., Ph.D., M.R.I.A.,
The Observatory, Armagh.

[No abstract.]

Tuesday, 10th December, 1946.

MR. F. J. COLE in the Chair.

“ BIRDS AT THE NEST.”

Illustrated by Slides from Photographs taken by the Lecturer.

C. DOUGLAS DEANE.

[No abstract.]

13th March, 1947.

MR. W. ERSKINE LINTON, F.R.G.S., in the Chair.

“ FISH OUT OF WATER.”

Q. H. GIBSON, M.D.

Abstract.

It is generally agreed that vertebrate life began in the sea. Study of the chemical composition of the blood of different vertebrates has shown that all are fairly closely similar. It seems probable that this is because the conditions under which life of the degree of complexity represented by vertebrate organisms is possible, are strictly limited. It is suggested that vertebrate life first emerged when the conditions in the sea became comparable with those found in the blood of modern animals.

The extension of vertebrate life from the sea first took place by the colonization of fresh water, which involved the development of mechanisms for the conservation of salts and the excretion of water. The forms which had become adapted to fresh-water life then re-colonized the sea, which had so changed in composition as to be unfavourable for the life of the cells of vertebrate organisms. They also extended through the amphibia to the land. The changes in nitrogen metabolism and methods of reproduction which accompanied these changes in environment were discussed by Dr. Gibson,

4th March, 1947.

THE EARLIEST IRISH CHURCH ARCHITECTURE.

O. DAVIES.

Plates I, II and III.

When Christianity was introduced into this island, it is natural that its places of worship should be modelled on one or more existing types of structure. Legends suggest that some pagan sanctuaries had been in the open air, stone circles or the like; and the remains at Killinagh (Cavan)⁽¹⁾ indicate a sacred area, not roofed though it may have contained roofed buildings. There may also have been palace-sanctuaries. In the Celtic lands within the Roman empire there were small square temples, whose form is not classical and so must be native.

To discover the form of our earliest churches, we may consider what sorts of structure we can infer to have existed in Ireland in the fifth century. The commonest monument of our countryside is the roughly circular rath, 20-40 yards across. There were many different types.⁽²⁾ Some were entirely roofed; this type has been proved on the Isle of Man to date back to the later Roman period.⁽³⁾ Such structures were, however, found suitable for worship. Others contained roofed buildings; both tradition and archaeological remains show that these were known in Ireland in the fourth or fifth century. Circular enclosures containing one or more buildings were commonly adapted or constructed for ecclesiastical purposes. Many old graveyards are circular, a good many on hilltops like the secular raths which they imitate. Well-known examples near Belfast are Armagh and Nendrum. These enclosures can never have been wholly roofed, and their walls must have been intended for protection rather than for shelter.

The megalithic tradition survived in the construction of long or round chambers, roofed with stone slabs or with a false dome. The distinction between the two types was rooted far back in the megalithic age, and their distribution in early Christian times corresponds roughly with that of the prehistoric passage and gallery graves. The form most commonly used for secular purposes in the first millenium A.D. was the underground souterrain, which in Ulster was usually a passage, in Leinster a domed chamber. Orthostatic walls had been abandoned in favour of small stones, and the corbelling of passage-roofs was no longer usual. The passage-structure had, as we shall see, some influence on the development of Irish churches. The circular chamber with beehive-roof was used in the west for subsidiary buildings, cells and so on, and has continued until recent times for tower-rooms of castles, sweat-houses and sties; but owing to the form of the Irish church being fixed under the influence of western Christianity, before eastern monks and missionaries made their way west in the seventh century to influence the still nascent styles of decoration, the eastern circular domed church never came to Ireland.

(1) *U.J.A.* 3rd Ser., ii, p. 98.

(2) *U.J.A.* 3rd Ser., x, p. 1.

(3) *Journal of the Manx Museum*, v (1945-6), p. 177.

In recent years there have been identified in various parts of Ulster the insignificant remains of various forms of hut, usually less than thirty feet across, in outline circular, rectangular, apsed or irregular. The walls rested on a foundation of stone but seem usually to have been of clay or of sods, which have disappeared. The roof was probably of light branches, perhaps covered with sods. Various lines of argument allow us to date some of these huts to the early centuries A.D. or even earlier; but a great deal of surveying and excavation will be required before a satisfactory series can be constructed. Walls of clay or sods, now nearly always rectangular, are common in the country to this day, and preserve archaic traditions. The typology of these huts is still too vague to allow us to see how far they can have influenced church-architecture.

Rectangular timber houses, gabled and with one or more rows of columns, existed in most Celtic lands,⁽⁴⁾ though they have not yet been proved archaeologically for Ireland. If timber is to be used horizontally, a rectangular form is imposed. Vertical timber was used in northern Europe, and is at the root of Norwegian mast-churches.⁽⁵⁾ It was used for the walls of Irish circular roofed raths, and a row of posts can be set on any plan desired. It has, however, grave disadvantages, the difficulty of making an opening for door or window, the liability of posts buried in the ground to rot, the impossibility of using large trees which would be too heavy to tip upright. Considering the history of the Celtic immigrations into Ireland, it would be surprising if the central European type of horizontal timber-construction did not reach this island.

The usual form of church in the western half of the Roman empire and the Balkans in the fourth and fifth centuries was the apsed basilica. Domed structures on a square or circular drum had not been acclimatised in the west, and though the domed church, basilican circular or cruciform, ultimately conquered these lands of the Orthodox church, it was a rarity in western Europe until the Renaissance. The long basilica, with nave and aisles, clerestorey and gabled wooden roof, is directly derived from timber-construction; and though the immediate pattern of the Roman basilica was in Athens, it was akin to many forms current in all the forested countries of the west.

The apse was not a universal feature of the Roman basilica, but was widely adopted by early Christian architects, because it could contain the seats of the clergy. When, however, in northern lands the Roman brick or stone was replaced by timber, the apse, which would be difficult to build, was bound to be pared away, especially as the extension of the sanctuary in Roman times into the body of the building and the simplification of the church-personnel in the west made it unnecessary. Thus, though the Roman church at Silchester⁽⁶⁾ is apsed, this pattern was not followed.

The Irish, having received their Christianity from the western empire, were bound by tradition to the rectangular form of church, and for this they had two models. In the extreme west, the stone passages with false barrel-vault, derived from the megalithic gallery, were used for churches like the Oratory of Gallerus and the older church at Kilmalkedar. Timber must have always been scarce in the west, and the hermits who took refuge there and founded little churches on barren headlands and islands would have been unable unaided to lift heavy beams into place.

(4) *Journal of Roman Studies*, xxi (1932), p. 96.

(5) Strzygowski, *Early Church Art in Northern Europe*, ch. IV.

(6) Haverfield-Macdonald, *Roman Occupation of Britain*, p. 207.



Fig. 1. Church at Roundstone, Galway.
Photo : R. J. Welch, Belfast Museum and Art Gallery. Copyright.



Fig. 2. Solomon's Temple.

From the Book of Kells.



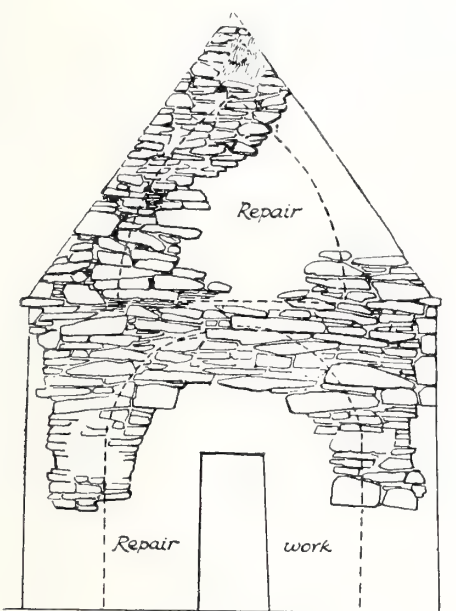
Fig. 1. Sarcophagus at Clones.



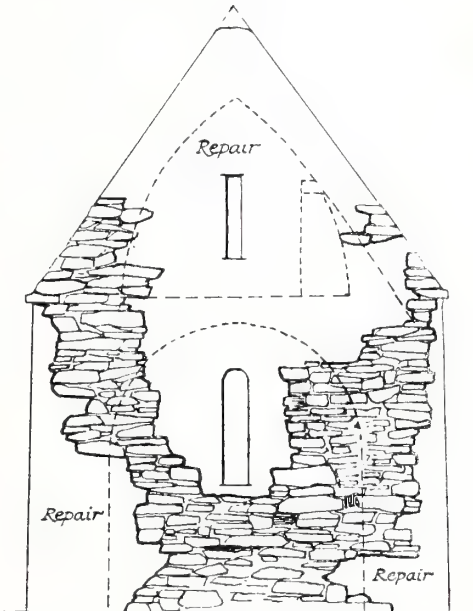
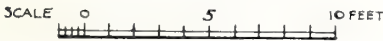
Photo : T. Predy.

Fig. 2. Banagher Church.
From *Preliminary Survey of the Ancient
Monuments of Northern Ireland*, Plate 47.

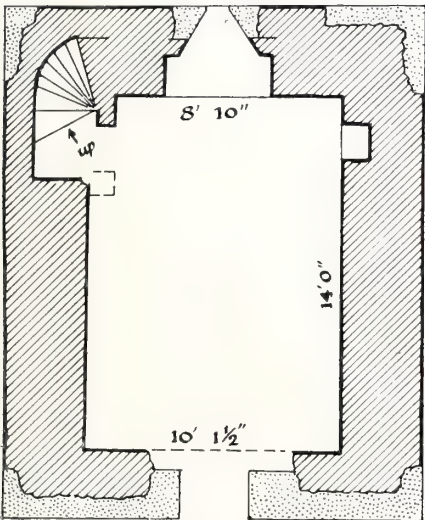
Saint Mochta's House, Louth. repaired 1934.



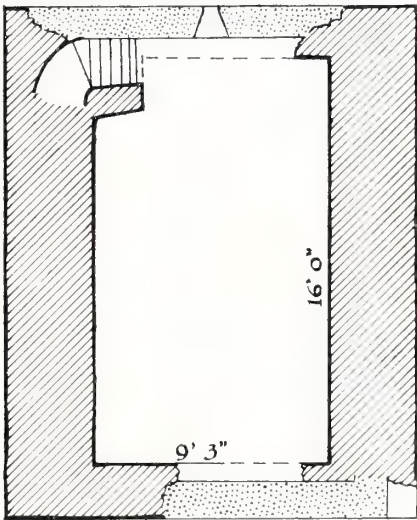
West Elevation



East Elevation



Ground Plan



Plan of Graft

Drawing by H. G. Leask.



The absence of corbelled churches, which are not easily destructible, from other parts of Ireland makes it certain that in the forested midlands and east coast the earliest churches were of timber. Early churches betray clearly their timber originals. The projecting ends of the long walls or antae, which are common, are derived from the four corner-posts of a rectangular structure, whose walls would be made of rectangular planks, attached to these posts. At Roundstone (Galway), the antae are continued up the sides of the gables (pl. I, fig. 1). Here we have a memory of a timber-frame, consisting of two pairs of corner-posts surmounted by gable-couples. On a few gables are roughly X-shaped finials, the survival of the crossing of the couple, whose ends would be carved into elaborate designs. A poor example is the later church at Kilmalkedar; more expressive of the original form of the finial, because probably copied from a contemporary wooden building, is the picture of Solomon's temple in the Book of the Kells (pl. I, fig. 2). In west Tyrone pairs of gable-finials, framing the ridge-pole and still recognisable on the crossing of a couple, survived until the sixteenth century at Island MacHugh and at Corick.⁽⁷⁾ The sarcophagus at Clones, built in the form of a rectangular structure, has weathered roof-finials (pl. II, fig. 1).

The gable-couples would be more secure and would exercise less lateral thrust if the roof were very steep; this would, moreover, throw off snow. Indeed, a grave disadvantage of the roof of the circular rath as reconstructed with a low pitch is that in snowy weather it would leak abominably. Early church-gables in Ireland are extremely steep. They were probably covered with slats; a few extant specimens have a stone roof (pl. III).

The heavy trabeated forms of early Irish architecture presuppose wooden originals. At Killeavy, Duleek and many other places are massive rectangular doors. Their slightly inclined jambs would have given stability to a wooden structure. Even after the introduction of the large arch heavy lintels remained popular, as at Banagher and Maghera (see pl. II, fig. 2), the arch being used only on the inner face. Small round arches for windows or the doors of round towers were frequently cut out of lintel-blocks.

The wide arch is found in the primitive church of Rahan (Offaly); but at the same period passages were still covered with false vaults of the Gallerus Oratory type, which was combined with the high-pitched roof to give the croft above the church.⁽⁸⁾

Irish architects, until they were strongly affected by Norman influences, did not develop the church beyond this stage. The tenth and eleventh centuries were a time of turmoil and disorganisation; so the novelty which appeared then was the fortified round tower, with which I am not here concerned. Moreover, the Irish found perfection not in size but in richness of decoration, and so sculptural ornament flowered at a time when architecture stagnated. Latin Christianity and the claims of Rome to world-empire were at a low ebb. The Irish, like the Greeks of the same period, perhaps expressed a conscious protest against the vast and stately forms of Roman architecture, whose effect depended on spaciousness; they created in its place a rich and highly ornamented jewel, four-square, self-contained, expressive of delicacy and pattern, fields into which the Romans have seldom been able to trespass without becoming ostentatious and vulgar.

(7) *B.N.H.P.S.* (1936-7), p. 14, stone A2.

(8) See *C.L.A.J.* (1937), p. 32; Henry, *Irish Art*, p. 99.

8th April, 1947.

MR. F. J. COLE, President, in the Chair.

BEES.

REV. R. DIXON PATTERSON, M.A.

Ever since that strange urge settled down upon man which sends him forth to master the earth and all that dwells therein the existence of the happy warrior has been an advance against clenched antagonisms at every step of the upward climb.

The great elemental forces of nature held him in awe as fire, water, earthquake, tempest fury, or lightning blast revealed their dread possibilities; huge and fearsome monsters opposed their strength and cunning to his weak body and half awakened brain; while death, borne to him by the mysterious agency of what we call Microbes, took weighty toll of him and his household; nevertheless he has not ceased from the strife till now the success of the great conqueror has become marked enough to tempt some to dream of a rapid and complete control over the forces of nature unwitting that the might, not of the apparently formidable but that of the meek of the earth, the Mosquito, the Locust, the Tsetse Fly, or the Driver Ants of West Africa, creatures whose extinction it would seem impossible to effect, will imperil man's control of vast regions forming some of earth's most desirable acquisitions.

Therefore attention will more and more be directed to the means of dealing with certain members of the Insect world; as has occurred at the cutting of the Panama Canal where the Mosquito scourge was mastered, or in South Africa when the ravages of the Locust resulted in a campaign for the destruction of their eggs.

But then all insects are not directly hostile to the well-being of man or animals. There are many that are simply indifferent and there are numbers that are useful to them—amongst these latter are the domesticated Bees.

The use of the term "domesticated" is to be observed because under the familiar title of "Bees" there is embraced a section of the Insect world the members of which are very diverse in their habits and about twelve thousand in number. Yet, amid many lesser differences, the fundamental distinction between them is that some are solitary in their disposition while others are social.

In the life of the Solitary Bees instances occur wherein the Mother Bee dies when she has laid her eggs and provided a store of food for the use of the larvae she shall never see; or in which she lives on to nourish and protect her offspring; and again cases in which the queen, sole survivor through the Winter sleep, forms a new nest in the Spring time when she gives birth to a family, so founding a society all whose members, with the exception of the mated females, die out when Autumn comes.

It may appear a contradiction in terms to say that sometimes Solitary Bees work in large groups but there is a difference between living in communities and living a social life. The famous French Naturalist, J. Henri Fabre, devotes

some of his most entrancing pages to telling the stories of the Sicilian Mason Bee and the Mason Bee of the wall. Practically the only point in which they differ is in reference to the site selected by each kind for placing its cells. Both shape them like thimbles cut lengthways, and both construct them out of chalky clay containing a little sand made into a paste by use of the creature's own saliva, but whereas the Mason of the wall will carry this mortar in her mandibles to a bare wall or a stone and there build her nest with it, the Sicilian Mason Bee selects for the same purpose the inside cheek of a seldom opened window, the branch of a shrub or tree, or it may be even the underside of the tiles covering a shed, and there multitudes of these creatures will build groups of cells placed in the closest proximity to each other and when the task has been completed the entire mass be made water and heat proof by a coating of earth and saliva mortar; nevertheless we have here the work of individuals each of whom fashions six or ten cells only and whose existence centres round this little collection of honey and eggs—they are Solitary Bees.

The same epithet applies to the Humble Bees dwelling, perhaps, in a hole some Field Mouse has deserted, where the eggs are laid in half a dozen cells of brown wax lying at the bottom of a grass and leaf made ball. Other examples of the same class which may be mentioned are:—the Rose Leaf Cutting Bees who sink a shaft in firm earth for some inches and having made it into a horizontal gallery proceeds to mould rectangular pieces cut from rose leaves into thimble-shaped cells till ten or twelve such receptacles have each been filled with honey, pollen, and an egg before one is placed with its base against the rose leaf cap sealing its predecessor. Then the opening leading to the collection is filled up and the worker goes her way. The Poppy Bee sinks perpendicular holes in dry sandy soil when nest-making. These she so lines with the petals of the common poppy that each red lined cell, when completed with honey, pollen, and egg on the top of the stores, can be sealed by covering the opening of the receptacle with the remainder of the poppy flower lining the wall thus preventing the soil or sand used for closing the hole falling into it. In the Carder Bee Great Britain possesses a class of insects which for a nest use homes left by other Bees or holes other insects have excavated in wood and then forsaken. The inside of the place chosen, she will completely cover with a network of cotton or wool, gathered from plants growing in the neighbourhood, and made liquid proof by the application of cement, thus securing the food needed for the nourishment of the oncoming generation.

Such Bees possesses but an academic interest for ordinary folks because Solitary Bees do not store supplies of surplus honey which we may take from them and use for ourselves, but Social Bees do work in communities and do store surplus honey so it may be fancied that they are the only Bees suitable for cultivation by persons seeking to secure a source for the supply of Bee products. There are, however, different kinds of Social Bees and they are, from this point of view, of varying values. In widely separated lands like India, Ceylon, China and far-away Java are to be found Bees large in size who construct their homes in the lofty trees or on the rocks. The combs they make, while possessing only one side, are at times as much as six feet long and perhaps three or four feet deep. One can get from such figures visions of abundance of honey yet these Bees cannot be domesticated because of their tendency to seek for a new habitation every two or three weeks and the fresh pastures are sought in some district generally more than a hundred miles away; moreover, their ferocity is such that sometimes they sting men and animals to death and makes it an impossibility to comfortably work with them. From the Island of Cyprus come

the Cyprian Bees. Smaller in size than the common Black Bee but more attractive in appearance by reason of the three yellow bands stretching across the back and under the abdomen, yet their bad comb building, too liberal use of the red sticky material called propolis, together with their liability to sting, renders them unsuited for popular use. Austria was the original home of the Carnolian Bee. The peculiarity of this race is the white bands on the lower portion of the stomach and their gentleness, beautiful comb building qualities, hard work and sparing use of propolis make them welcome to the discerning Bee Master. Many persons, it may chance too many, are familiar with the Italian, or Ligurian, Bees which have now been imported from North Italy to such an extent that by cross breeding with them the purity of our native stock is threatened. Not unlike the Black Bee in shape, though lighter in colour and distinguished by three yellow bands dividing the abdomen, they are tireless workers and not good comb makers. Sometimes they are unwilling to fill the crates and liable, if not pure in strain, to be troublesome, not to say dangerous, to manipulate.

So, at last, we come to the familiar Black Bee—the natural Bee of our own land and, taking it for all in all, the one best suited to its climatic and other peculiarities. Excellent workers, good breeders, builders of beautiful combs, sealing the ripened honey with white cappings, and capable of being handled without their tempers causing any exceptional perturbation.

Studying the physical structure of this insect we notice that it is clothed with a horny substance made from chitin and also for the most part covered with hairs of the same material which are used as organs of touch, brushes, tools for pollen gathering, and body protectors.

That body is divided into head, thorax, and abdomen.

In front of the head of the Drone and on the top of the heads of the Queens and Workers three simple eyes are arranged like a triangle which are supposed to enable the Bees to judge of distances outside the hive and to see amid the darkness within. A compound eye is placed on each side of the head, being largest with the Drones and smallest in the case of Workers. These eyes are really a combination of eyes—a mighty collection of six-sided lenses; those in the eye of the Drone numbering 26,000, in the Worker 12,000, and in each eye of the Queen 10,000. There is no room for wonder in the fact that Bees can see in apparently every possible direction.

Bees communicate with each other by means of their antennae or long sensitive organs situated close to each other in front of the head and so controlled by three muscles that they can be turned in every direction. The most important organ in the mouth is the tongue which is covered with a hairy sheath and having at its extremity a spoon-like formation also covered with hair—where liquid abounds the tongue operates by sweeping backwards and forwards while the spoon is employed where but little fluid is to be obtained. Scientists are endeavouring to breed Bees with longer tongues because the longer the tongue of the Worker Bee the greater the number of flowers from which nectar may be obtained and it is one of the valued features about Italian Bees that they possess long tongues yet, even with their assistance, the honey flow of Red Clover is lost to Bee Masters.

To the thorax three pairs of legs are attached.

The first two, in the pro-thorax, form the comb by which the thorax is cleaned. The second pair of legs are attached to the meso-thorax and they carry a lever for removing from the hollows in the legs the balls of pollen which have been carried from the flowers and trees of gardens and fields to the store cells of the hive. The third set are connected with the meta-thorax and are

formed with nine joints, two of which are used as pincers to remove wax flakes when they are formed in the ventral plates beneath the abdomen and another two form the baskets for the transport of pollen. Neither Queen nor Drone have these leg nippers as they do not make wax, and with them the pollen baskets are likewise wanting since they do not forage for pollen.

The flying apparatus consists of a pair of wings in front attached to the meso-thorax and a second pair behind them joined to the meta-thorax. Hooks are placed on the outside, and upper, edge of the hinder pair of wings while the lower, and inner, edge of the two in front is folded into a plait so that when the front pair spread out to fly the fold catches the hooks on the wings behind and by this device the four wings become two.

Worker Bees have the shortest and Drones the longest wings. Both can fly backwards at will and are able to stop very suddenly even when in full flight. Their speed attains to between 15 and 20 miles an hour, though when returning homewards laden with spoil this may be reduced to between 5 and 7 miles each hour. Weight and weariness may combine to produce this diminution in speed for the Bee's range of operation when foraging generally embraces an area of 2 miles but may extend to 7 should necessity arise.

Breathing takes place through inlets in the sides of the body called spiracles of which there are 7 on each side. These the Bee can open or close at will thus sending air to a network of tubes, or tracheae, which when so filled increase its size and in this way make flight an easier matter by changing its specific gravity.

The thorax, which is that part of the trunk stretching between the neck and the abdomen, is with the Worker Bee covered by a multitude of long feathered hairs useful for pollen gathering, while those on the Drone Bee are short and spiny, useless save only for the purpose of clinging closely, and the Queen Bee is almost entirely wanting in a hairy coat of any kind.

In the abdomen of the Bee are situated the stomach, the honey sac, and the chyle stomach. The gullet runs from the mouth through the thorax to the chyle stomach and thus connects them. The stomach mouth is so placed between the stomach and the honey sac that, when she desires to do so, by moving certain muscles the Bee can send the nectar she has gathered along the gullet and mouth into the cells as unripe honey or pass the contents of the sac through the stomach mouth to the chyle stomach where they will be digested into food for the nourishment of the young—more particularly the young Queens.

The organ by which the Bee is most generally remembered is her sting. This dreaded weapon is composed of a horny sheath with a sharp-toothed edge which is used to guide the darts forming the real stinging apparatus. The darts, which are themselves grooved and barbed, spread out under the surface of a wound while the poison glands at the top of the sheath discharge a secretion which, flowing down the grooves made in the darts, enters the wound between the barbs. Neither the act of stinging nor the withdrawal of the sting is the momentary action it may appear since before it takes place the Bee has used her feelers, or palpi, to ascertain if the spot selected for the operation can be pierced and their delicate hairs, aided by sensitive nerve points, supply the desired information. If allowed time the Bee will herself gradually remove the weapon by turning the sting round and round as if withdrawing a screw, but if she is roughly brushed away her sting, torn from her body, is left in the wound where the poison sac and the gland continue to discharge their supply of formic acid, while eventually the Bee herself dies as the result of her mutilation.

The sting is, in reality, only a greatly altered form of the egg-laying machinery and is therefore a female organ, the Drones having no stings and those possessed by the Queens being longer than the stings of Workers, in shape slightly curved like a scimitar, and used principally in the slaughter of rival Queens. The most important organs of the Queen are: the ovaries where the eggs are developed; the oviducts along which they are passed to their places in the cells; and the spermatheca situated directly under the ovaries and containing the 25,000,000 spermatozoa said to be put there by the Drone on the nuptial flight.

To some slight degree what may be described as the public life of the Bee has long been known to the curious, for men have been making use of Bee products for thousands of years. Not only did the Ancient Egyptians regard honey as a food and employ it as an embalming material but they were accustomed to make small wax figures of men and animals to be consumed as part of the ritual connected with magic rites, but the real secrets relating to her life and conduct were closely hidden in the darkness concealing the combs of the hive. Virgil, the Roman Poet who wrote about 70 B.C., tells how hives were made by plaiting osiers and bark together, giving the construction a covering of mud to render it rain proof. It was probably this primitive home that originated the familiar skep of straw, often strengthened by a framework of either cane or hazel rods, so winsome in pictures of rural scenes—thatched cottage with old-world garden, abundance of old-fashioned flowers, row of skeps, and a quaintly clad, kindly faced, ancient Bee Master hovering in the background, the whole bathed in the golden sunshine of a summer afternoon, though to the informed suggestive of unpleasant happenings centred round sulphur candles and brimstone—which was the dwelling place of the Black Bee but is now being gradually displaced by the modern bar frame hive, an invention we owe to the researches of men like Huber and Dzierzon, so we should know something about this result of their labours since to it we are indebted for so much of our information concerning the Honey Bee and her ways.

Briefly it may be described as a wooden box with an inside 18 inches long, 17 inches wide, and $9\frac{1}{2}$ inches deep—the outside being wider, longer, and deeper. This part of the hive is called the body box; it is occupied with the frames containing the cells in which the eggs are laid, the brood reared, and the surplus honey, intended for winter stores, hoarded. The space inside the body box is large enough to hold eleven bar frames each of which is 14 inches long, $8\frac{1}{2}$ inches deep, and $\frac{1}{2}$ an inch thick. Each frame is fitted with "shoulders" to rest upon the top of the inner walls, a Bee way of $\frac{3}{8}$ of an inch is secured between the sides of the frames and the walls of the box as well as another of $\frac{1}{2}$ an inch between the bottom of the frame and the floor of the hive. The frames are so placed that even when fully drawn out the combs are still sundered from one another by a space of $\frac{3}{8}$ of an inch and this is very necessary because if they were too close the Bees would join them together and, on the other hand, if too far separated would use propolis for the same purpose. When the full number of frames is not required in the body box a sheet of wood, with "shoulders" similar to a frame and known as a "dummy," is put behind the last one used so that the size of the chamber can be proportioned to the number of Bees contained in it.

"Supering" is the technical term used to designate the method by which surplus honey is obtained by placing sections, or frames, over the brood nest-sections for comb honey and frames to get extracted honey.

The section crate, or rack, is really a bottomless box constructed to hold 24 wooden frames each $4\frac{1}{4}$ inches square and capable of holding 20 ounces of honey. This crate is laid on the top of the brood nest and when the nest is packed

with Bees, if the honey flow is good, they will go up into the sections, using the entrance made for them by cutting away part of the wood on all the sides, and store surplus honey there—a strong stock being able to fill three or four crates during one favourable season.

Certain apparatus are necessary for the use of the person desirous to investigate the interior of a Bee hive: they are a veil, a smoker to subdue the Bees, a carbolic cloth damped with carbolic acid mixed with water, and, perhaps, a pair of gauntlet gloves. Thus equipped we are in a position to make interesting discoveries about this new world of the small but far from insignificant. There are three kinds of Bees in each hive at breeding time: One Queen reigns there whose function is to be the mother of the entire community. Longer in shape, darker in colour, and slower in movement than the others, she may live some years and when the Spring comes she alone of all those living with her in the hive—amounting at that time to some 30,000 or 40,000 Workers with 300 or 400 Drones—has lived through a Winter and from the moment when first she began to deposit her eggs after the Winter sleep the task continues without interruption for weeks throughout the whole twenty-four hours at an average speed of slightly more than two eggs each minute or three thousand during that time, so in the passing of the brief span allotted to the normal life of a Queen she places in the cells 1,500,000. The egg is like a small piece of thread, bluish white in colour, slightly bent, broader at the base than at the top, and though only the sixteenth of an inch in length yet the total laid is numerous enough to form a line reaching for a distance of one and three-quarter miles.

Next the Workers demand attention because they really dominate the little kingdom, the Queen being but an egg-laying machine whose activities they control by leading her from cell to cell for egg-laying, supplying food to or withholding it from her according to the abundance or scarcity of the honey flow. They are neuter in sex since their breeding power has been lost, for though it is true that some of them can still, under the pressure of dire necessity, lay yet only Drones are hatched from their eggs.

The male element in this community is supplied by the much abused Drone. He neither gathers nectar, builds combs, produces propolis, nor seeks pollen but, the gallant gay Lothario of the hive, he glories in a brief day and at last perishes miserably.

Doubtless there is a place and a work for all. It evidently must be so when the population rises from about 3,500 at the start of the season to, it well may happen, 60,000 or 80,000 during the time of the fruit or clover harvest.

There is much work to be done indoors for the home must be kept spotlessly clean, therefore workers labour ceaselessly to remove all dust from the broken cappings once used to seal the honey and store vats, the dirt of the hive for even Bees in their comings and goings as well as other ways leave a residue of refuse, fragments of combs, pollen dust, the bodies of the dead, the cleanings of the used brood cells, the remains of chilled brood—all these unlovely things must needs be brought outside and cast away. Some there are who dream that Bees have a selected spot to which they carry their dead—it may be beautiful to think of them as acting so, yet it is but a dream.

Combs require to be made stationary, connections between combs may become necessary, above all draughts must be excluded, therefore a reddish coloured sticky material gathered from such trees as the Pine or the Horse Chestnut and called propolis is indispensable and much energy is expended in its acquisition.

The fertilizing dust of flowers, to which the name of pollen has been given, is valuable in the Bee economy alike as a food and as material to mix with wax

when Queen cells are needed, for by its use both ventilation and safety are secured for the precious inmate.

Then the main business of life has to be attended to by providing food for those who will live to see future days, and so all through the fleeting hours of sunshine tireless toilers ply their task of filling the cells wherein the honey and the pollen are stored.

The inside of the hive may become too warm and workers lower the temperature by introducing a continuous stream of cold air from outside—a feat which is accompanied by a row of Bees standing one behind the other completely round the inside of the hive from one side of the door to the other and all diligently fanning their wings so as to draw the cool air in at one side and, after sending it all round the hive, expelling the warm air at the other.

When the Bee has emerged from her cell on the 22nd day after the egg has been laid and rested for twenty-four hours she begins her life of service for the community, being employed during the next fourteen days at the work of nursing the larvae and at the end of that period being allowed to enter upon her other duties as a pollen and nectar gatherer.

One of the most remarkable peculiarities connected with Bee breeding has reference to the effects of the feeding given to the young. The eggs deposited by the Queen have all the same outward appearance of shape, colour, size, and surface covered with a fine network of raised lines, but whether it will develop into a Queen, a Worker, or a Drone seems to depend entirely upon the nature of the food supplied to the little legless, almost maggot-like, grub or larva which is born from the egg—though it is probable that the egg from which a Drone is hatched is one that the Queen has allowed to pass into the cell unfertilized. This food is given on the fourth day when the grub is three days old. During these three days it has lived on the nourishment contained in the egg and the substance now given, called Chyle food, milky white paste in appearance, very acid and pungent to the taste, pre-digested and poured out from the crop of the Nurse Bee. When three or four more days have passed a mixture of half digested honey and pollen is added to the diet and on the ninth day the cell, well filled with food, is sealed. The nourishment supplied to the Queen differs from that given to Worker and Drone inasmuch as the “Royal Jelly” is richer in food content and is continued all through the larval life.

Thinking about the food of Bees there is a possibility to stress the importance of honey to the comparative neglect of pollen as an article of diet, yet this fertilizing dust is so indispensable to the welfare of the hive that where it is scarce during the first days of Spring the Bees may be assisted and encouraged in their breeding by placing flour near the hives where it may easily be found or by dropping some into the empty cells of a drawn out frame which is then put beside the brood combs. The natural pollen is, however, much to be preferred and it is one of the joys of a Bee Master to linger near his colonies and watch the hurrying inmates scurrying through the thronged door each with her little ball of pollen borne in her corbicle, or pollen basket, placed one on each of the third pairs of legs. From the observation of the home-coming Bees and their movements he can tell much about the state of the hives within and the activities of the insects without, for abundance of pollen generally implies a well-stocked hive and the colours of the pollen basket tell where the Bee has sipped: orange won from dandelion; deep rich brown from gorse and flowers; gold from charlock; different shades of russet from white and red clover, or it might chance saintoin; pale yellow from apples; greenish white from blackberry; and black from the poppy or red from the crocus. To observation succeeds satisfaction at the awareness of all the bustling haste implies for the coming

harvest and marvel at the mind behind the worker leading her to visit flower after flower all of the same kind so as never to mix the pollen as she discharges her unwitting task of fertilizing plant after plant, each after its own species.

The home requires the protection of guards because wasps and robbing bees, as well as other intruders such as mice or snails, might try to force an entrance, so sentry duty forms an additional labour for the worker and one that very often leads to bitter conflict, wounds, and death. Woe to the stranger bees void of the peculiar smell common to all inmates of that domicile; the passport is wanting and expulsion will certainly follow. Others are stung to death or entombed in a coating of propolis as the bodies of mice and snails may bear witness when the time comes to give the hive its Spring cleaning.

For several purposes heat is required in the working of the hive. It is a requisite for the rearing of brood, the ripening of honey, and the production of wax. This heat is generated by the Bees themselves—aided at times by the wise forethought of the skilful Bee Master. In addition to brood rearing heat is a requisite for the production of honey because the liquid the foraging Bee secures during her visits to flowers is a sweet fluid called nectar which is hidden in the honey glands of the plant. This nectar is taken by the Bee through the gullet into the honey sac where there are certain glands whose secretions transform the cane sugar of the nectar into grape sugar. Next it is pumped through the mouth into a cell and it then contains a large amount of water. This water must be evaporated, therefore the hive is heated and sometimes as much as one pound weight of water passes by this method from one pound weight of honey before the cells holding it are sealed.

When manufacturing wax for comb building the Bees first gorge themselves with honey, then proceed to gather in clusters, hanging from the roof of the hive in festoons, while the heat within the hive is slowly raised till it reaches between 90-95 degrees Fahr. After twenty-four hours tiny white specks appear in the ventral plates below the stomach and these little flakes of wax are so thin and light that it would take one hundred of them to equal the weight of one grain of wheat. When they appear the pincers on the third pair of legs remove and hand them to the Worker Bees who mould and construct with them the waxen walls, works of art and haunts of mystery. Wax is a valuable commodity for the twofold reason that from ten to sixteen pounds weight of honey are used in the production of one pound of wax and because of the time thus lost to nectar gathering when at best the season is short and the opportunities for work uncertain. A fact that led to the production of wax foundation by Messrs. A. I. Root and E. B. Weed whose labours have caused a great host of Bee-keepers to hold their memories in a gladsome reverence.

In the construction of the combs much skill is shown. The bar frame, ultimate product of the ingenuity of Langstroth, contains 104 square inches on each side, and if we estimate the number of cells at 28 to each inch we obtain a total number of 5,824 on each frame, so diligent use is made of space and material at every point suggestive of mind.

The cells are not simply drawn straight out of the comb base, if they were their contents, in whole or in part, would fall out of them, so they are tilted slightly upwards and this is obviated.

There are Transitional cells, Queen cells, Drone cells, and Worker cells. The transitional cells are built only to connect the cells of Workers, Drones, or Queens, and are irregular in formation. Those of the Workers and Drones, being six-sided, are most perfectly adapted to the shape of the Bees besides having the advantage of being most economical in space—square or triangular shaped they had not fitted the bodies of their inmates while if circular in shape the result

would have been a loss of space, but by the design now employed all these advantages are secured with the addition of mutual support between them. Worker cells measure half an inch deep and one-fifth of an inch wide. The cells of Drones, beside being three quarters of an inch deep and one quarter of an inch wide, are easily distinguished on the brood frame because they stand out from the face of the comb and are straw coloured. Queen Bee cells are built on the edges of the combs, shaped like an inverted acorn and one inch long. Owing to the fact that a mixture of wax and pollen is the material with which they are constructed they are porous. It is the task of the Great Mother to furnish a rapid succession of Brood and during the busy season a young active Queen could occupy almost half a frame each day with her eggs, but congestion is avoided by the constant stream of young Bees hatched and pouring out of the cells thus making room for their successors in an endless torrent of living entities. It may assist us to understand the process of continuous filling and emptying if we ponder this statement of facts as they occur:—

	Queen.	Worker.	Drone.	Days.
Incubation of egg ...	3	3	3	„
Feeding of larva ...	5	5	6	„
Cell sealed on the ...	9	9	9	„
Bee evacuates the cell	16	22	25	„
Interval in the hive ...	5	14	14	„
Bee flies ...	21	36	39	„

Under such circumstances the home eventually becomes so densely populated that the Bees prepare to seek a new dwelling place and, as the first step towards the accomplishment of their wonderful adventure, build Queen cells—perhaps some ten or twelve in number—with the addition of, it may be three hundred others, for Drone rearing. The cells having been provided and eggs laid therein it only remains for the planners of the high enterprise to go about their daily avocations and wait with patience the action of the Power outside the hive who quickens into life the eggs of Queen and Drone. In due course the anticipations, conscious or unwitting who may venture to decide, become realities as life becomes motive in Queen and Drone cradles. Soon the males be seen scampering over the combs, helping themselves freely to the painfully-garnered and jealously-guarded contents of the honey vats, or with noisy buzzings hieing forth to disport themselves by flight through warm summer airs over perfume-laden fields—to the casual onlooker an existence of seeming brief, aimless, self-pleasing indulgence though, in truth, one behind which lurks the burden of imperious obligation to perform an all-important function for the benefit of the community and one whose fulfilment is possible only at the price of his own life. He dies and by his dying many live.

Stealing quietly through his Apiary at some eventide during the leafy month of June, or thereabouts, the Bee Master will linger near his hives with gladdened heart as he listens to the deep, deep hum from within that tells of a dense, diligent, and contented proletariat thronging every nook and corner of the little city state. In some of them, however, that pleasing sound will be broken by noises subdued but distinct as the horns of elf-land faintly blowing, they are the cries of the young Queen about to be born and the trumpeting causes a commotion among the dwellers on the combs for it warns that the change, so earnestly desired and so carefully prepared for, is close at hand. The Workers may hail with glee the challenging notes but they stir the reigning Monarch, the teeming mother of them all, to fury so that she seeks to kill her rival but, finding herself prevented by the body of Bees escorting her and guarding the acorn-shaped cell, realizes that an unexpected, and hitherto unprecedented, problem must be dealt

with. She has not much of a mind to grapple with it for that feeble brain, weighing only the one hundred and seventy-fourth part of her entire mass, has turned almost to pulp by reason of the strain the reproductive organs have made upon her vital energies, yet there steals upon her the knowledge that since no two Queens can exercise their rights at the same time in the same hive and she had not been permitted to destroy her successor before her exit from the cradle it becomes evident that a new home must needs be sought and found. The question remains as to whether the decision is really made by her or by her subjects. Someone must weigh the need and resolve on the action to be taken that it may be met and to speak, as Maeterlinck does, about "the spirit of the hive" as the governing factor at all such moments of crisis is exceedingly like evading the confession of mental processes at work but, leaving for the time being the consideration of this question of guidance by mind, we note that there are those who say the Queen is the source of the upheaval since it was, they assure us, her will that determined the swarming should take place, while there are others, of equal skill in Bee lore, who maintain the burden of responsibility rests upon the general body of the Workers who issue the decree for emigration and compel the obedience of an unwilling Ruler. Certain it is that the resolution once taken is followed by the wildest of confusion, demoralising the activities of this generally so ordered commonwealth; we may not know the reason lying behind that utter abandonment of discipline but we cannot fail to remember that on ordinary occasions the Bee returning from her outdoor task betakes herself immediately to the discharge of that indoor duty which some hidden Power outside herself has laid upon her and at it she toils with apparent concentration of all her faculties while at this time of the great outgoing such implicit obedience to obligation is spurned. The dwellers in the hive make holiday—probably the only gaudy day known in their short, strenuous lives—ceaselessly they fly in circles round the walls of the home, by their excitement the heat of the dwelling is raised rapidly and greatly till, it may hap, that the wax in the combs sags, threatening to collapse beneath the weight it supports of stores, and eggs, and larvae. At the same time the Queen, usually so deliberate and dignified in the movements which keep her close at all times to the centre of the combs where her attendants lead her from cell to cell and stand waiting while she, after examining the cell, inserts the end of her abdomen into it, gives an upward jerk, and emerges leaving an egg standing on the base, repeating the operations time after time as cell after cell is visited, now becomes the living embodiment of ill-regulated expenditure of energy pushing her way over the bodies or among the surging multitudes stirring in tumultuous unrest on all sides. Then a tide of life turns towards the door, thousands and thousands of Bees hurry through, some to fill the air with noise of happy buzzings, others to crawl up the front of the hive, and some few others to begin a search for a place wherein to make the home to be. Thousands, however, still remain within the old city guarding, befriending, or, it may chance to be, controlling the hesitating Queen who not once nor twice has visited and made retreat from the open door only after further parleyings to approach it once again. It is not easy to sunder connection with the only home she has ever known, so one, reading perchance his own feeling into the Queen's position, can understand and respond to her emotion, but her subjects show neither sentiment nor sympathy—with them it is her duty to go and duty must be done. For the last time she has reached the entry and led, or driven, emerged into the fresh air and bright warm sunshine—two blessings and beauties last seen and fully enjoyed on the day of her wedding flight certainly contrasting sharply with what she had since then known in the artificial ventilation and dim interior of her little city.

Marvellous is the sacrifice made by that short passage from darkness into light. The Queen has left behind not merely thousands of workers set apart, by some decree whose source forms portion of the charm and mystery pertaining to the hive, for the discharge of commonplace tasks and who do it though their little world would appear to be in dissolution. In the fields they collect as usual the nectar, the pollen, and the propolis so needed for the workings of the hive, in eager throng they hasten homewards with their gains ignoring the commotion within, they give themselves to cleaning the hive and attending to the cells wherein the brood awaits the summons of life—these are left behind and so are also some eighteen thousand larvae, thirty-six thousand nymphs, seven or eight royal princesses, and ten thousand eggs, besides a vast quantity of honey and other stores. Truly the outgoing means starting life afresh.

The appearance of the Great Mother on the lighting board produces the wildest excitement amongst her subjects and as she rises into the air they surround her like a noisy breeze-blown cloud. To the casual spectator the swaying mass may well appear a dangerous collection of angry insects bent upon attack but the sound they make is the hymning of a deep gladness rather than the paeans of battle music—their Queen is in their midst, possessing her they hold the key to the future perpetuity of the community and that suffices them. True it is an occasional aggressive individual flying near threatens the onlooker, but such an one does not form a member of the migrating throng, neither does she share their hopes, for she belongs to the section left behind to keep the hive in fit condition and wait the coming of the new Queen; so on duty bent she had gone to the fields and chances to be returning to the hive from labour in the outside world, but that fact is what makes it possible for her, should she so desire it, to sting—she alone is able to curve her abdomen without which power no sting can be inserted. Each Bee when frightened by an unwonted disturbance on the outside of the home, by the use of the smoker or carbolie cloth to subdue, above all by such an internal irruption within the dwelling as swarming, instinctively prepares for any eventuality by hurrying to the honey vats and drinking deeply—an action which, while reducing the surplus honey, at the same time rendering it impossible for her to sting since the food she has swallowed makes bending her abdomen beyond her power. Consequently, fearsome in her hostility as she may appear to the nervous, the swarming Bee is incapable of giving pain—the sweetness she has swallowed making her a thing of innocence and beauty. For a swarm of Bees is a thing of beauty both in flight, like a cloud of silver, and in quietness hanging down, from some branch of a tree or other temporary support, like a vast bunch of grapes. This position of settlement must soon come because the weight of eggs she carries, the weakness of her little-used wings, in addition to her want of familiarity with the brightness of Summer time—and swarms take place only on sunlit days—make it difficult for the Queen to travel very far, therefore a convenient spot is selected where all can come together with the Mother of the race and wait the return of the scouts sent out to discover a suitable site whereon the city-that-is-to-be may be erected.

The ruling of the law on this matter reads that so long as the owner can keep his fleeting Bees in sight regardless of where they settle down they still remain his property and as such are liable to be claimed and removed by him, so the settling down is the act connected with the removal eagerly desired and carefully watched for by the Bee Master. Various methods were, at least in times past, employed in the endeavour to bring it about; sometimes tin cans were beaten in the belief that thus the truants would believe that a thunderstorm was coming; at other times water was sprayed upon the swarm to give the

impression that a shower of rain was falling, and surely the persistence of the practice justifies the faith prompting it.

Once the cluster has taken shape and the stillness of expectancy fallen upon it there is but little time to be lost for the scouts may return at any moment with the information that will cause the entire body to rise and float away upon the breeze like a piece of frosted gauze, therefore there must be a hurried capture of the waiting swarm by getting it into a skep, or some other receptacle prepared for the purpose, all the while taking most particular care to secure the Queen for if this is accomplished the Bees will remain in the temporary accommodation given them till, with the coming sun-down, they can be driven into the bar frame hive which is to be their home. There the work of building the new city will immediately begin. The supplies of honey brought by the emigrants for food and wax-making being straightway augmented by the gleanings from the countryside, so the cells for brood and stores are quickly constructed lest precious hours be lost thus delaying the Queen's egg-depositing with fatal results to the future of the community.

No change occurs in the forsaken home for some days after the old Queen has turned away from it, but she has left behind, amongst so many other valuables, several acorn-shaped cells wherein Royal nymphs are sleeping. The eggs from which they were hatched had been deposited at different times so that they should be born at succeeding intervals thus rendering it possible for them to have several more swarms, or casts, should such a proceeding be desired.

In the meantime the occupant of the first sealed cell may be heard stirring within her nursery and endeavouring to win freedom by gnawing at the edge of the cap covering her lodging while the Workers try to assist her from outside by thinning the walls that imprison and protect her. The twofold labours end when she succeeds in pushing out her head and portion of her body, for at that moment the Bees selected to be the guardians of the Queen help her to step out upon the comb where they brush and clean her. Great indeed is her need of assistance for she at the moment of birth is pale and trembling, but in what seems to us a few brief moments strength come to her limbs and a fierce longing restlessness to her spirit. She realises that she has been born a Queen but with that knowledge comes likewise an awareness of rivals who must be removed before she can reign, so straightway she begins a search the end of which must be their destruction.

A crisis has been reached alike in the life of the young Queen and of the community.

The Ruler just arrived is their sovereign who, when she has been mated, can lead the state along the paths of prosperity and peace, but there are yet other youthful Queens awaiting birth and if they are allowed to live in a due course the Queen already in their midst will lead forth another swarm, to be followed by others as the royal nymphs are successively hatched, so that eventually the city will be utterly exhausted and destroyed—all this may be avoided if the slaughter of the still unborn Rulers is permitted. Consequently the choice must needs be made. If more swarms are to take place then the Queen will be prevented in all her efforts to kill her rivals and they will be kept in their cells by the simple expedient of placing more and more wax on the top and walls as the prisoner hearing, and replying to, the trumpeting of her enemy tries to cut her way out to liberty and conflict till after some days the hour arrives, by whomsoever decided, when the duty devolves upon the baffled Queen to lead out the first "cast" or secondary swarm. This may be the last allowed or it may be followed by more till the "swarming fever" has destroyed the community.

The Bees may, however, decide to allow no swarming and the massacre of the Princesses be permitted to take place immediately or be deferred until the new Ruler has returned from her "nuptial flight."

Once the controlling agency of the commonwealth decides that the deed of removal is to be performed, whether immediately or after the return of the newly-wedded Queen, the guards stand aside as the angry Sovereign, seizing upon the first royal cell she can reach, and using teeth and claws to strip off the wax, tears away the silky case, or cocoon, that coating the walls of the cell inside covers the youthful princess and then, should the nymph be recognisable, stabbing her victim till death brings release. So she moves on from nursery to nursery repeating the operation, the Bees around coolly watching her working and when each one has been destroyed flocking to it that they may drag out the body of the murdered Princess or the still living larva and cast it out of the hive that they may feast themselves upon the remains of the royal jelly still adhering to the walls about to be cut away—it may even happen that when the Mother Bee becomes too weak or too weary to complete this task they themselves will act as executioners and instruments of demolition.

By the decision to allow no more swarming one outstanding problem of the moment has been solved; still, though work is now resumed, there yet remains for fulfilment the all-important duty of the young Queen's wedding and some dangerous possibilities, due to weather conditions and attacks from birds, renders the safe return of the Bride a source of some concern. In preparation for that event the Bees have brought into existence, and continue to nourish, some three or four hundred idle males who, while the Queen delays her excursion, revel wildly and wastefully on the treasures of the hive, each male requiring the incessant toil of six workers to supply his needs. The honey sac of the Bee can contain one-third of a drop of nectar and the customary load carried on the homeward flight is one-fifth of a drop (facts which lead us to think of the labour expended to produce one pound weight of honey and to marvel at the long-suffering which endures the wilful rioting of the Drones in their midst. Every necessity, however unpleasant, is grimly borne with for the sake of the function they discharge and it is known that the time of waiting will not be prolonged for the Queen must be wedded within twenty days after her birth or for ever remain a virgin Ruler, capable indeed of egg-laying but Drones being the sole product, so that once more extinction for the Bee city stands at the end of the vista. Eagerly, therefore, are her movements watched throughout the interval of five or seven days during which she wanders over the face of the combs till the appointed morning dawns and she, coming to the hive door, sees the beautiful world outside where the sunlight floods the fields where the careless Drones are sporting. Sometimes a lonely figure and at others the centre of a host of keenly interested subjects, she advances coyly only to retreat and then return again, but at last, full of nervous excitement, she comes out upon the alighting-board and, with her head turned to the hive, gradually raises herself into the air; swaying round and round before her home as if studying the position of the place she is leaving, she moves in ever-widening circles, curving higher and higher, then rushes faster and faster into the upper air followed by a host of Drones who had been gazing at the fleeting vision and probably drawn by the scent thus diffused. One by one they drop out of the chase for the race is to the swift and the battle to the strong, but there is no pause made in that swift career so at last it is only the very strongest can reach where she has attained and there in the heights they meet and mate—the Queen returning to the kingdom wherein she is to reign and, save at swarming time, never to leave, laden with

25,000,000 spermatozoa, and the other, with his life function completed, to drop earthwards a mutilated corpse.

The arrival signifies that the community has been delivered from the imminent danger of extinction and the appearance of the first eggs placed in the cells by the Queen seals the certainty of the future. One likes to think of the warmly welcomed Monarch as enthroned in a kingdom moving to ever greater prosperity after perils past. It might be so only death comes soon or late.

In some countries men who follow the gentle art of the Bee Master have deemed that Bees knew and cared for those who tended them so they were accustomed to tell them when the Bee Master had died. Yet such a thought is but a fond fancy for the Bee knows neither owner or attendant because its own life is exceedingly brief, lasting, in the summer season, only about six weeks. It is a full one, but daily the fraying of her wings by the cutting edge of plant leaves and grasses lessens the lifting power of her wings till one day in the act of settling down another piece is removed and, never able again to rise, she waits for death down among the roots.

When Autumn comes and nights grow chill, when the honey flow grows less and the days grow shorter, the death of the Drones is decreed. The wretched creatures seem to know the fate awaiting them. Some there are who going forth at morning time find that they are not allowed to re-enter when evening falls; others refuse to leave the shelter of the hive and are pitilessly pursued all over the combs by Workers until, amid their outcries and struggles, they are caught and dragged, wounded and fighting desperately, to the door of the hive, whence flung to the ground they are left to die in misery.

Beautiful and strange are some of the imaginings woven around the attitude of Bees to the Queen. She may continue to exist for five years, but even under natural conditions she is worn out in three or four, while the Queen, living under the conditions prevailing in an apiary, is exhausted after two years of laying. Old Queens have been found deposed and living in hidden corners of the hive they once ruled over but still supported by the inmates, yet such a discovery is far from the general rule because when one grows too old to be of use, or becomes injured, or has not been properly introduced into the hive, the end is death. The proceeding known as "Balling the Queen" is characterised by the inspiration of the most calculating and deliberate callousness. No single individual will accept responsibility for the act, therefore as many as space permits join in the deed. One by one approaching and fondly stroking with their feelers the Ruler-about-to-die, they crowd her in on every side till she is imprisoned in the centre of a solid mass and all the Bees composing it squeezing with a gentle but relentless pressure which may be continued for twenty-four hours without a break and, when at last the ball dissolves into its living atoms, she is found to be either suffocated or so severely injured that death follows almost immediately.

Such is the constitution of the almost fearsome community that beats out its life to the monotonous music of never-ending toils and with relaxation coming only in the performance of some new task for the benefit of the commonwealth.

Some there are who say we are dealing with nought but complicated machines moving automatically to the performance of certain acts as the response to stimulus, while there are others who are equally convinced that behind the

movement and the achievement lurks the working of some kind of mind—therefore we pause to ponder over the marvel of the mind of the Bee and, perchance, to question whence it came.

The senses of the normal human being—sight, hearing, taste, feeling and smell—are all part of the endowment of the Bee.

Sight is hers in rich abundance. The vision clear through the dimness of the hive and the glories of the day are both alike made possible by the provision of the principal eyes and the secondary organs with their many thousands of facets. Not the gropings of feeling but the directness of sight enables this creature of the glooms and the lights to pass so speedily and surely from flower to flower in the fields and to the nursery or store cells in the house of the waxen walls.

There must be some inner response to the stimulus of outward sound though it may come through the instrumentality of sensitivity to vibration rather than by the use of the organs we are familiar with as ears, but the peculiar feature about the sense is that while one may produce any degree of noise at a distance from the home the inmates will not make response in any way while a blow given to any part of the hive will immediately produce a reply most likely to be unwelcome to the operator outside and the trumpeting of the unborn Queens within their cells is potent enough to provoke the old Queen to wild paroxysms of jealous hate.

The ability to taste belongs to the Bees. The fact that nectar is sweet must needs have a reason and its attractive power for insects, and above all for the Bees, would appear to be the true explanation. The Bee knows nothing about the work it does as a fertilizing agent but it does know that the nectaries of certain plants contain a pleasant drink, consequently they hasten to enjoy it. It is the same sense that enables them to identify sugar and honey as desirable when met with outside the hive.

Knowledge can become their possession by the use of their feelers, or palpi, and it is thus the Bee about to sting ascertains the suitability or otherwise of the spot she is about to pierce. Swift as the act of stinging may seem to the person operated upon, still it has been preceded by an examination of the place and a decision made on the information conveyed to the brain of the operator. There is some kind of language used among these creatures and they communicate with one another by means of their feelers, or antennae, employing signs to convey the ideas occurring to them. The antennae are two tube-like hair-covered bodies placed near each other in front of the head and, because united to it by a joint and moved by the action of three muscles, capable of being turned in every direction. The feelers of the Queen and the Workers consist of 12 joints while those of the Drones contain 13 each. We say, perhaps somewhat casually, that Bees in this way talk to one another by signs but let it not be forgotten that sign language requires some kind of code and the composition, as well as the learning, of a code implies the possession of mind and memory.

Smell is evidently another sense they touch life with and is perhaps the urge that makes them ply the task of cleansing the hive from the defilement of the dead or the unclean; that acts as a passport for the Workers returning to the hive from labours abroad; that directs their wanderings among the blossoms; and most assuredly there can not be the least doubt about their objection to the smell of ammonia whether in the perspiration of horse or human,

or that much of the trouble experienced from their irritation when examining a hive is to be attributed to this cause when a nervous operator, or one heated during a summer day, tries to perform the task of manipulation—but, be it remembered with appreciation, it is likely the fumes of the “smoker” or carbolic cloth produce their effects by acting upon this same sense and bringing them into that blissful condition we describe as “subdued.”

The contacts established with the world by the assistance of the senses bring information and this knowledge becomes, to some degree at least, a permanent possession through the Bee’s endowment of memory. It is this that enables her to return home from her long journeys—extending at times from five to seven miles—and to find her own particular dwelling place amidst a number of others. The appeal she makes to memory is particularly manifested by the actions of the young Queen about to set out on her nuptial flight. Most carefully does she scan the position of the hive with reference to the landscape and the remainder of the hives before setting out on the flight so fraught with destiny for herself and others. The result is nearly always a safe return though there are times when the similarity of the hives in shape, colour, and proximity of position may, just as with men and women, cause confusion as memory fails to distinguish.

Moreover it is but brief in its operation for if we remove a Queen from her hive and keep her away for a few days we will find that the Workers will proceed to construct Queen cells by the simple process of enlarging some of their own into Royal cradles and having thus secured safety for the future will forget all about the old Ruler or, if remembering her, so resent her absence that they will “Ball” her when she at length returns—she is valued not for herself but for the benefit the community may secure by her means.

Somewhat allied to memory is the awareness Bees can show with reference to the passage of time as has been proved when they have been trained to come to a definite place at a fixed hour and find honey exposed there for their delectation. When considering this piece of educative work it must not be forgotten that before these experiments were carried to a successful conclusion the element of time calculation, conscious or otherwise, lies behind all the work of the nursery.

Colour has a place as an aid in their work because the Bee on foraging duty is careful not to mix the fertilising dust of different colours or species of plants either when in the world outside or when storing it in the hive garner—there all pollen is sorted according to its source and colour.

They have discovered the secret of rest and production through division of labour. Where the nectar and the pollen lurk in most abundance from day to day is known to the hidden Power behind the activities of the hive and this agency directs the Workers to the most profitable fields so that some are sent to toil among the limes while others are hastened to the white clover or the sage, while more remarkable still is the fact that the Bees who the day before were nectar-gathering will to-day rest their tongues and the glands of the honey sac by gathering pollen—so is it controlled that the energies of the hive do the most work with the least exertion and in the shortest possible time.

The sense of proportion, amounting to astonishing accuracy, is shown in the construction of the cells each, after its kind, so perfect and each so very similar

in shape, colour, and size that there is no trace of the experimental about them. The very fact that at times another shape of cell, we call them transitional cells, is employed to unite those of Queens and Drones and Workers, thus obviating any gaps in the combs, emphasises the control exercised by some authority—a mastery whose empire is still further submitted to when the Queen refuses to deposit eggs in such structures knowing that the offspring coming out of such nurseries would be deformed. The work of this engineering craft places the combs with passage way among and around them; it inclines the cells at an angle of four or five degrees that thus they may be able to hold their contents; and this it is that has taught them to barricade the hive from the attacks of the dreaded Death Head Moth by the erection of waxen barriers at the door, each being separated from the other by a distance too narrow to allow the Moth to pass through.

Let it be for ever borne in mind that engineering skill, however highly developed, is but the instrument used for the outward expression of ideas and thoughts are the offspring of mind. That Bees can change their manner of life and can at times make mistakes proves the truth of their reasoning power. They may, when labouring under unfavourable circumstances, misjudge the Bee spaces around or between the combs and proceed to rectify matters to the utmost of their ability by making the comb that had been built too near its neighbour bend away from it or even by constructing a makeshift comb in the space between the two, but never will they attempt to perform any impossible work. Let it be remembered that while they have lived their own life and tested their own methods of doing things for thousands and thousands of years our intimate acquaintance with them is but a thing of yesterday, nevertheless even this so brief intimacy has shown us how much they can adapt themselves to environment. Their ancestors lived in warm lands under the open sky but those coming after them and dwelling in climates that were temperate or cold no longer made their homes in hollow trees or the holes in rocks or hung their combs from branches where the bodies of the Bees served to protect the eggs and stores. Reasoning power, not merely the response of reflex action moved by stimulus, comes into play when pea, or other, flour provided by the Bee Master is, in times of scarcity, accepted and used instead of pollen or a man-prepared substitute for propolis meets with employment as readily as the natural article. Variation of constitutional practices to meet altered circumstances occurs with differences take place between the dwellers in neighbouring hives at swarming time whether attributable to inherited tendencies or to the nature of the influences, alike outside and inside, brought to bear upon those who make the decisions; it is this same power of adaptation to environment that leads the Bees like the common Black Bee when transported to regions of perpetual summer to learn in the course of a season or two that storing is unnecessary labour since they live in a land where supplies are obtainable all through the year; once more, the work of nectar-gathering is wearisome and even Bees, as robbing shows, may be wishful to collect the honey with greater ease—some kinds of Humble Bees have found a way to do this by simply biting a hole at the base of the red clover flower while others enter at the mouth of the bloom; when the first bloom comes to the Scarlet Runners some individual Bees hasten to secure the coveted fluid in the orthodox manner but somehow they quickly find out that it may be gained with less trouble by biting a hole at the bottom of the flower and proceed not only to do this but to improve upon the device by using it with the yet unopened bud—a wrong employment of intelligence but it works and the virtuous, strenuous, toiling Black Bee not seldom acquires the art of resorting to the same trick,

only she applies herself to the opening already made by the Humble Bee. Adaptibility—Intelligence—Mind.

Such are some of the agreeable mental characteristics of the Bee, but just as she is hideous in her personal appearance so there may not, in any candid relation, be omission made of certain other features much less winsome in their nature.

The Bees is the embodiment of slavery to the masterdom of cold, calculating intellect.

She is callous to the last degree. In the city all the Workers are apparently linked in comradeship but outside all strangers to one another and even at home the unity is but in the seeming. The Bee, stintless outpourer of the wine of life in service, slave of the community, thrall of the unborn future, knows neither friendship nor gentle pity. The "Balling" of the Queen and the massacre of the Drones points to the existence of a hardness that, shown to the full on special occasions, is ever present. The fellow-toiler at her side may fall crushed and mangled but she pauses not amid her activities to take notice of the broken body but the Worker rendered useless for further service is immediately destroyed. The licence to live is paid for by toil and when, by any means, the fee cannot be paid the licence is immediately withdrawn.

Insects like Bees, Ants and Wasps form a world wherein it seems difficult to deny the operation of limited mind, and the flash of light that comes with this thought suggests the possibility that some man, of even greater genius than Huber or Langstroth, may arise to show us how to subdue the citizens of the waxen walls by that mind contact and control we call "hypnotism" rather than by the use of such crudities as fumes from the "smoker" or the carbolic cloth. However this may chance to be realised in actuality, the haunting problems for some of us are connected with the Source outside from whence comes the Mind inside the hive and what is the relation of that hive mind to ours with, in addition, what guidance may be derived from it to assist man's groping after solutions to many problems now vexing human thought and moulding human conduct.

Flower in the crannied wall,
I pluck you out of the crannies,
I hold you here root and all in my hand,
Little flower—but if I could understand
What you are, root and all in all,
I should know what God and man is.

So sang Tennyson of the crannied flower—may we not say the same of the self-sufficing Bee?

126th SESSION.

ANNUAL MEETING.

The 126th Annual Meeting of Shareholders and Members was held in the Old Museum Buildings on Tuesday, 4th November, 1947, at 3.30 p.m., and among those present were Dr. Allworthy (in the Chair), Messrs. J. M. Capper, Arthur Deane, W. E. Linton, Em. Prof. W. B. Morton, Messrs. A. G. Pomeroy, J. Crawford Shaw (Hon. Treasurer) and James R. Young (Hon. Secretary).

APOLOGIES. Apologies for absence were received from Professor Flynn and Professor Sinclair.

NOTICE OF MEETING. The Notice convening the Meeting was read by the Hon. Secretary.

ANNUAL REPORT. The Chairman called upon the Hon. Secretary to read the Annual Report of the Session.

THE ANNUAL REPORT OF THE COUNCIL FOR THE 126th SESSION, 1946/47:—

Your Council record with regret that the President, F. J. Cole, M.R.S.A.I., is unable to preside at this Annual Meeting which brings our 126th Session to a close. The Honorary Secretary has been requested by Mr. Cole to convey his apologies and to state that he has asked Dr. Allworthy, the immediate Past President, to occupy the Chair. The President, whilst still confined to bed, we are glad to state is progressing satisfactorily.

SHAREHOLDERS AND MEMBERS. The Shareholders and Members now number 152.

NEW MEMBERS. Two new Members were elected during the Session.

It is with sorrow that we record the death in January, 1947, of Colonel R. G. J. Berry, J.P., M.R.I.A., a Belfast man who served through the South African Campaign, 1899-1902, with much distinction. He joined our Society in 1919 and took a deep interest in the Archaeological Section, of which he was Chairman for a time. Elected to the Council in 1935, his experience and advice were invaluable. He contributed to the "Proceedings" of the Society and to the "Ulster Journal of Archaeology." Colonel Berry, on resigning from the Society owing to ill-health, was elected an Honorary Member in November last.

We also desire to record the death on the 30th April last of the great Ulster Scientist, Sir Almroth Wright; on the 21st February, William H. F. Patterson who was Honorary Treasurer of the Society; on the 8th February, John Bristow, Shareholder, a former Under-Sheriff of the County Antrim and a leading figure in the Legal Profession in the Province; also James Gorman, Member.¹

RESIGNATIONS. The resignation of four Members occurred during the Session including that of Oliver Davies, M.A., Chairman of the Archaeological Section, who will be leaving Belfast shortly to take a Chair in South Africa, whose loss will be keenly felt by the Archaeological Section.

LECTURES. Six interesting Lectures were given during the Session. The severe weather affected the attendance at the four Lectures given in 1947. The President welcomed Members of the newly-formed Belfast Centre of the Irish

1. Obituary Notices appear on pages 123-128—Ed.

Astronomical Society who attended the instructive Lecture given by Dr. E. M. Lindsay, Director of the Armagh Observatory, on "Astronomy and the Amateur." There was an excellent attendance at the Lecture "Birds at the Nest" by C. Douglas Deane, illustrated by slides from photographs taken by the Lecturer, to whom a vote of thanks was proposed by Mr. Linton and seconded by Father Shields, who said it was good to see Mr. Deane's son following in his father's footsteps.

EXCHANGES. The ordinary work of acknowledging the exchange publications and dividing between the Library of the Museum and Art Gallery and the Library of the Queen's University has been carried out as usual during the past year. The letter sent out with last year's "Proceedings and Reports" brought applications from forty exchange societies for back numbers published during the War. Some Irish MSS. are still on loan to the National Library, Dublin, where photostat copies are being made. Your Council decided to forward a copy of the Society's Centenary Volume to each Society and Institution on its Exchange List.

Your Council tenders their thanks to Mr. A. H. George for looking after the Exchanges so ably.

REPORT ON THE PROPERTY. Your Managing Agents—Messrs. A. H. Davison & Dickey—report as follows on No. 7 College Square North:—

No vacancies have occurred during the year and the long-term lettings remain as before, namely The Royal Society of Ulster Architects, Ulster Academy of Arts, Workers' Educational Association and the Ulster Hospital Libraries Association. The lettings to the Belfast Naturalists' Field Club amount to £14 10s. 0d. and to the Christadelphian Ecclesia £95 0s. 0d., while the rents from occasional nightly lettings during the year amounted to £77 17s. 6d. During the year the staircase, entrance hall and ladies' and gentlemen's lavatories were redecorated. Before this work could be done quite a lot of replastering work had to be carried out, but the work done has effected a great improvement to the Building. Another essential job done during the year was the repair and glazing of three dome lights on top roof and the glass roof over the Architects' room.

COUNCIL MEETINGS. Six Council Meetings were held during the Session which were well attended. Under the Constitution five Members now retire by rotation—Messrs. Linton, Pomeroy, J. Crawford Shaw, Professor Gregg Wilson and Mr. W. H. Workman—all of whom are eligible for re-election, with the exception of Professor Gregg Wilson who does not wish his name to go forward.

ARCHAEOLOGICAL SECTION. During the Session—under the direction of Professor Estyn Evans—the Chancel Arch of the ancient Church of St. Mary's, Ballaghanery Upper, Co. Down, has been partially restored. Grants have been given towards Excavations at Cist, Waterfoot, and at Rath at Lissue. During the Session Lectures were given by Dr. G. Bersu, F.S.A., Oliver Davies, M.A., and H. G. Leask, M.R.I.A. Professor Estyn Evans was appointed Delegate of the Section to the Congress of Archaeological Societies which met in London on the 30th November, 1946. The Section places on record the valuable work done and interest shown by the Chairman, Oliver Davies, M.A., and the Secretary, Francis J. Cole, M.R.S.A.I., who will be unable to continue in office—Mr. Davies leaving Belfast, as previously referred to, and Mr. Cole finding it impossible to undertake the Secretaryship for a further period.²

FINANCIAL STATEMENT. The Report of the Hon. Treasurer, J. Crawford Shaw, F.C.A., is as follows:—

2. No Annual Report for the Session 1496-47 has been received from the Archaeological Section.—Ed.

REPORT OF HONORARY TREASURER.

The year commenced with a balance in the Bank of £152 3s. 4d. and ended with £21 2s. 5d.

Whilst the income from rents and subscriptions has shown little variation as compared with the previous year, the expenditure has increased by £175 0s. 0d. mainly due to the painting and repairs of the Society's property in College Square North.

The expenditure on Lectures (including advertising) was £68 0s. 0d. and for the Archaeological Section £46 0s. 0d.

Your Council deemed it desirable to assist the Queen's University in their endeavour to raise money for the Centenary Endowment Fund and a Grant of £25 0s. 0d. was made for Scientific Research. A grateful acknowledgment has been received from the President and Vice-Chancellor, Sir David Lindsay Keir, M.A., LL.D.

As the income from the property should, in the coming year, show an improvement, I am hoping that a larger bank balance will be available.

ADOPTION OF REPORTS. In moving the adoption of the Annual Report and the Honorary Treasurer's Financial Statement the Chairman, Dr. Allworthy, said:—

“ One hundred and twenty-six years ago a group of Philanthropists and worthy citizens met together for mutual improvement and founded this Belfast Natural History and Philosophical Society.

“ We still hold the same interests and ideals in view and we are always pleased to add to our numbers and welcome new members.

“ It has been said that to philosophize, in a just signification, is but to carry good breeding a step higher.

“ For the accomplishment of breeding is to learn what is decent in company or beautiful in arts; and the sum of Philosophy is to learn what is just in society and beautiful in nature and the order of the world.

“ Regarding the succession of the sciences as they exist to-day, they must be recognised as the most brilliant achievement of the mind of man.

“ Professor Albert Einstein, of relativity fame, added this significant line in a letter to the late Dr. D'Arcy, Archbishop of Armagh:—‘ In these bad times the best consolation is to occupy oneself with the timeless problems.’ ”

Mr. A. G. Pomeroy, in seconding, congratulated the Council of the Society on presenting such a satisfactory report and statement of accounts; everything was in first-class order. The motion, on being put to the Meeting, was carried unanimously.

ELECTION TO COUNCIL. The Chairman called for nominations to act on the Council.

In proposing the election to the Council of Messrs. Linton, Pomeroy, J. Crawford Shaw, J. C. Taylor and W. H. Workman, Mr. J. M. Capper said it gave him great pleasure to make the proposal. As a Member he received the excellent Programme of Lectures and realized that the Executive had spared no pains in securing Lectures of interest. The proposal was seconded by Professor W. B. Morton; and as there was no further nominations it was agreed to unanimously.

The Chairman then announced that a short Meeting of Council would now take place and reminded the Members that the first Lecture of the new Session would be given by Mrs. A. K. Leask, on “Art in Irish Churchyards,” at 8 o'clock that evening.

The Meeting then terminated.

OBITUARIES.

COL. ROBERT GORDON JOHN JOHNSTONE BERRY, R.A.S.C. (Retd.),
J.P., M.R.I.A., F.R.S.A.I.

The death of our good friend and colleague, Col. R. G. Berry, on 9th January, 1947, aged 76, at his fine house, Ardaluin, Newcastle, Co. Down, fronting the peaks of Mourne, whose antiquities, history and folk-lore he knew and loved so well, has meant a sad loss to this and other Societies which he served so long and faithfully.

Born in June, 1870, elder son of Matthew West Berry, M.R.C.S., L.R.C.P., a surgeon practising in Belfast and Larne, who was also a Count of the Brazilian Empire, and coming of a family long settled at Gartross House, near Moira, R. G. Berry was educated for the Army at the Military College near Oxford, and, as a young officer in the Army Service Corps, served with credit through the South African War, being twice mentioned in despatches and awarded two medals with seven clasps. Subsequently, he served in West Africa as a Major, and in due course retired. Rejoining the Army for the First World War, he did good work again as a Lieutenant-Colonel in the R.A.S.C.

Even when age and failing health made active military service impossible, as President, and one of the founders of the Newcastle Branch of the British Legion, he represented it on the Northern Ireland Area Council, and devoted himself unsparingly to welfare work among the troops in his district.

So, at the end of his days, military honours were given at his funeral, to the quiet churchyard of Kilmore, near Armagh.

In the absence from Ulster of Col. Berry's immediate descendants, and of the family papers, now in S. Wales, the writer of this memoir owes his best thanks, for much help as to the connexions of the Berry and related families, to that accomplished Ulster genealogist, Mr. R. W. H. Blackwood, J.P.; to Major Terence Greer Johnston, R.A. (Retd.), M.A., T.C.D., of Wild Forest, Castlewellan, a cousin of Col. Berry, one of an old professional and business family long settled in the Lurgan district; to Mr. Arthur Deane, F.R.S.E., M.R.I.A., our President, and his ever useful *Centenary Volume* of our Society, particularly for the late R. M. Young's account in it of Gordon Augustus Thomson, of the Jenny-mountain family, that great world traveller.

Thanks are also due for answers to specific questions, or for references, to Professor Mary Williams, formerly of University College, Swansea, now of Finchley, Col. Berry's Literary Executrix; to Capt. Desmond F. Berry, of Penarth, S. Wales, Col. Berry's son and Executor; and to notices in the Belfast newspapers.

George Benn's *History of Belfast* has, of course, though not infallible, helped also as to the inter-relationship of several old Belfast families. For more recent years the scholarly history of "M.C.B." has been a sure guide.

But, in spite of diligent search, many seemingly simple questions remain unanswered, many gaps appear in the tale, and mistakes may also have escaped notice. Time and other conditions did not suggest, or admit of a search in the Registry of Deeds. For these and other failings the writer craves pardon and kind correction.

But Col. Berry lives in our memory less as the gallant soldier than as the courteous, scholarly, and travelled antiquary, widely read and deeply interested in the life, customs, and beliefs of the pre-Christian or early Christian peoples of Western Europe, and especially in the folk-lore, legends, sagas, and history of the mountain area Downpatrick, Lough Neagh, and Dundalk, before the coming of Patrick and the other early saints. So let us look to his ancestry rather than his training for that breadth of vision and intellectual sympathy not usually credited to the military mind.

Owing to Col. Berry's son and Executor, Capt. Desmond F. Berry, living at Penarth, S. Wales, the Berry pedigree and family papers there cannot at present be perused, though believed to be long and interesting. On the father's side, the Berrys of Gartross House, near Moira, were there from the eighteenth or early nineteenth century at least; and inter-married with well-known old business and professional families such as the Wests of Dublin, and the Johnstons of Lurgan and Belfast. To the latter family, established in Ulster in the mid-seventeenth century by Rev. Thomas Johnston, M.A., Edinburgh, belonged Mr. Philip Johnston, Mayor of Belfast in 1871, and one of the most generous early benefactors to the Methodist College, where the Philip Johnston Scholarship keeps his memory green; and several others who gave worthy service in civil or military life, such as Sir Robert Stewart Johnston, C.B. More remote collateral kinsfolk are the Watsons of Brook Hill, Lisburn; the Gages of Rathlin; and the Harveys of Malin Hall, Co. Donegal. Later inter-marriages link these Johnstons, through the Greers, with the Hancocks, once of Lisburn, Lurgan, and Dublin.

On the distaff side Col. Berry came from several of the oldest families in or near Belfast, some of whom have played a leading part in the early history of our Society, or of the cultural, municipal, and industrial institutions of Ulster.

His mother, Mrs. Georgina Berry, was a daughter of Robert Thomson, D.L., of Jennymount, and a niece of that indomitable world traveller, Gordon Augustus Thomson, who spent a long adventurous life wandering over strange continents and stranger seas and whose vast and valuable ethnographic collection, presented to this Society, now enriches the Belfast Municipal Museum.

A generation earlier, Mrs. Robert Thomson was Alicia, daughter of Cunningham Greg, of Ballymenoch, near Holywood, an eminent merchant of great wealth and influence. Yet another generation, and the mother of Robert Thomson of Jennymount (Mrs. John Thomson of Jennymount), was Anne, daughter of Walter Wilson, of Croglin, Dumfries, and Maryville, Malone, ancestor of that great ship designer, the late Walter H. Wilson, partner in Harland & Wolff. Again, the mother of John Thomson, of Jennymount (Mrs. Robert Thomson, of Castleton, near Belfast, married 1761), was Jane, daughter of Benjamin Legg, of Malone. Through this marriage Col. R. G. Berry was also a cousin of that famous Naturalist, John Templeton, of Cranmore, Malone (1766-1825).

Belonging to a district a few miles from ancient Armagh, and growing up when the old bardic literature of Pagan Ireland had come to a new birth, but when training as an excavator was obtainable only by the very few who had won a high honours degree in Greek and Latin or in Semitic Languages at one of the older universities, and had also such ample means as would put them beyond the need for earning their living, young Captain Berry would naturally approach Pre-Christian Ireland rather as a student of its legendary sagas, religious beliefs, and social life, than as a modern excavator with his meticulous survey technique.

CAPT. R. G. BERRY AND THE ULSTER JOURNAL OF ARCHAEOLOGY, SERIES II.

As early as 1896 R. G. Berry collaborated, as an expert on the pre-Christian history and traditions of S.-E. Ulster, with the Rev. (later Canon) H. W. Lett, A.M., M.R.I.A., and W. J. Fennell, the Architect-Antiquary, in their detailed and still valuable illustrated account of "The Great Wall of Ulidia," the so-called "Dane's Cast" or "Glen of the Black Pig," to which that great Antiquary, the Rev. Dr. Wm. Reeves, had drawn Mr. Lett's attention on a railway journey many years before. [U.J.A., II Series, Vol. 3, Pts. 1 and 2.]

In 1898 Capt. R. G. Berry, Army Service Corps, Shorncliffe, was writing in the same Journal, learned articles, illustrated by plans, on "The Royal Residence of Rathmore of Moylinne, with Notes on other Early Earthworks in Ulster." Among these the great fort of Lisnagade, near Scarva, Co. Down, was described and planned.

There followed his Active Service in the South African War. In 1902-3 Capt. Berry's address was given as Dundalk. In 1906 Major R. G. Berry, M.R.I.A., wrote an article on "Costume in Ancient Ireland," and, in 1906-7, a long paper in four parts on "The Whites of Dufferin and their Connections."

A few years later he was on foreign service, and stationed in West Africa, where he was able to study primitive social conditions, and to form and send home a fine collection of tropical *Lepidoptera*, as well as a remarkable assortment of West African carved wooden figures of cultural or religious importance, some of which are now in the Belfast Municipal Museum.

His rejoining the Army for the First World War in 1914 seems to have sent him to Malta on duty, where he visited prehistoric sites in the Mediterranean area, and formed a specially fine collection of clay figurines of the Mother Goddess, now also in the Belfast Museum.

COL. BERRY AND OTHER SOCIETIES.

Col. Berry became a Life Member of the Royal Irish Academy in 1905. He was also a Fellow of the Royal Society of Antiquaries of Ireland for many years, and in 1922-3 was made its Local Secretary for North Down, and later transferred to South Down, holding that post until his death. He regularly attended its annual antiquarian excursions, and, during that Society's last visit to Belfast, was of great help in showing the members some of the chief antiquities of South Down.

Of our Sister Society, the Belfast Naturalists' Field Club, he was also an active member, ever helpful both as a lecturer, and as a guide on its many visits to antiquities in his district. (See the *Proceedings* of that Society.)

Among his other interests was Freemasonry, in which his kindly and generous nature found congenial scope, and won him an honoured place as a member of Mourne Council of Knight Masons, No. 16, and of Donard R.A.C. Yet another interest was Psychical Research.

COL. BERRY AND THE B.N.H. AND P. SOCIETY.

The new Archaeological Section of our Society formed early in 1918 mainly by Sir Charles Brett, LL.D., and Mr. H. C. Lawlor, M.R.I.A., naturally appealed to Col. Berry, who joined our Society and the new Section in 1919, and was elected a member of the Section Committee in 1924, a position he held almost continuously for some twenty years.

In 1937 he was elected Chairman of the Archaeological Section, and held the post for four years, including the difficult period of 1940-41, when the War stopped excavation by the Section. For over twenty years Col. Berry was one of the most active and helpful and best loved members of our Society, and, though living so far from Belfast, served on its Council from 1934 till November, 1946, when, a few weeks before his death, he resigned his membership of our Society, through failing health, to the great grief of his colleagues. The Council at once unanimously elected him an Honorary Member of our Society. Our letter telling him of this was among the last that reached him.

THE DRUMENA EXCAVATION.

Having a special knowledge of the many prehistoric structures and ancient tracks in the Castlewellsan district, Col. Berry undertook in 1925 the troublesome and thankless task of rescuing from imminent destruction, excavating, and repairing the large and interesting cashel at Drumena, with its remarkable pick-axe shaped souterrain and axe shaped monolith.

This task, which was beset with difficulties from the start, not the least of which was the absence abroad of Professor R. A. S. Macalister, whose guidance had been so valuable at Nendrum, occupied some two years, and yielded scarcely any definitely datable finds.

But Col. Berry's well illustrated Report (*Proceedings*, 1926-27), with its references to the Cult of the Axe in prehistoric Mediterranean lands, and to the possibility of Drumena being the scene of the invasion in the Saga of *Conghal U'airingneach* (*Irish Text Society*, Vol. 5) is well worth further study, and more consideration than it got at the time.

Mr. Andrew Robinson's rather negative criticism, of course, must also get due attention.

For accounts of the primitive Mediterranean cults of the Axe, and of the Mother Goddess, see Angelo Mosso: *The Dawn of Mediterranean Civilisation* (translated by M. C. Harrison), 1910, Unwin; Harold Peake and H. J. Fleure: *Priests and Kings*, 1927; Harold Peake and H. J. Fleure: *Merchant Venturers in Bronze*, 1931, Oxford University Press.

Without attempting to make a list of Col. Berry's writings, some other interesting papers by him may be mentioned to show the breadth and variety of his knowledge, e.g.: The Celtic Mother Goddess (1930, March); The Nature of Man (with lantern slides) (1931, Dec.); Emania (Archaeological Section, 1935-36); Irish Kingship (Archaeological Section, 1939). He was also a very active member of a Sub-Committee of our Society conducting a survey of the antiquities of the Emania district, c. 1934-6.

Though not a trained excavator by recent standards, Col. Berry, a man of wide culture and experience, kept in touch with those who were, and with their results, and regularly attended for that purpose the meetings of the British Association, especially those in its Section for Anthropology and Archaeology. From his reading and travels he left at his death a great number of notes and references on his favourite subjects to his Literary Executrix, Professor Mary Williams, late of University College, Swansea, and now of Finchley, London, with a view to their possible future publication, should conditions permit it,

To our Society and its district Col. Berry's influence was chiefly in his throwing light on the working of the human mind in the earlier and darker periods of its development, and on the social and religious ideas and customs of man in his long, painful struggles towards what we glibly call civilisation.

This task he carried on faithfully and gladly, with a serenity which recognised criticism and was unruffled by abuse. Once, after listening quite calmly to a rather virulent attack on a part of his learned lecture, by one who knew less, he replied quite gently: "As regards the remarks of Mr. X, some years ago I also held those views, but further study convinced me I was wrong."

As a Member of Council or Committee, Col. Berry was all that a loyal, friendly, and honourable colleague should be.

Col. R. G. Berry was twice married. In February, 1894, he married Miss Georgina J. Strickland Hannay, daughter of Robert Strickland Hannay, M.D., and a near relation of Rev. Robert Hannay, D.D., Vicar of Belfast (St. Anne's, now rebuilt as the Cathedral). During this marriage, when not on foreign service, Major and Mrs. Berry lived for some years at Richhill Castle. There were several sons and one daughter of this marriage. The eldest son, Robert Gordon Berry, married in 1923 Florence, daughter of John Morris, of Moore Allerton, Leeds, but died in his father's lifetime. The second son, Lieut. Henry Arthur J. Berry, died unmarried on service in Egypt in 1930. The third son, Capt. John Desmond White Berry, born 1903, a stockbroker by profession, now Executor of his father's will, lives at Penarth, South Wales. The daughter, Eleanor Grania Georgina, married, in September, 1928, Harold Mansell Baggett. Mrs. Georgina J. S. Berry died in October, 1914.

Col. Berry married secondly, in January, 1926, Mrs. Olive H. Campbell, daughter of John Hornidge, J.P., of Calverston, Mullingar, and widow of Lieut.-Col. James Campbell, D.L., of Sligo. She died in February, 1939.

And so farewell to our kind friend, starting on his longest journey, below those mountain peaks where, serene above clouds and storms, dwelt, as men thought, the Shepherd of the Stars. And, when for us the shadows lengthen, the evening sky glows, and the daylight fades, may the Good Shepherd, not of the stars only, but of men's souls, straying on many tracks, steep, stony, and storm-swept, gather us all at last to the green pastures of His eternal fold.

R. S. LEPPER.

JOHN BRISTOW.



MR. JOHN BRISTOW.

Mr. John Bristow, of Greenview, Dunmurry, was a shareholder of this Society from 1903 until his death in February, 1947, in his 81st year. His was a family which had, for many generations, been intimately connected with the life of Belfast, notably in church and banking circles.

Mr. Bristow, born in 1866, was a son of the Dean of Connor, and was educated at the Belfast Royal Academy, at Rossall in England and Trinity in Dublin. He then began his career as a solicitor in the office of James Torrens, a firm which later became known as Torrens & Bristow. Mr. Bristow was a man of wide interests, and the activities of the Society had always a strong appeal for him.

The Bristow Family reaches back into the annals of Ulster. Originally from Yorkshire, there were two brothers here at the end of the 17th century. The elder, Peter, left his wealth to his brother, Roger, who was

agent to the then Lord Massareene. Peter died in 1702 and Roger in 1745. Roger's third son was the Rev. Skeffington Bristow, Vicar General of Connor and Prebendary of Rasharkin. His fourth son was Rev. William Bristow, for 60 years Vicar of Belfast and Sovereign of the town for eleven. Roger's grandson was Skeffington Gore Bristow, 1763-1798. His third son, Skeffington Gore, 1763-1798, married Alicia Thomson, and one of their sons married his second cousin, Jane Smith, eldest daughter of Sam Smith, of Balmamore. Both James and Jane were descended from David Smith, Sovereign of Belfast 1699-1700.

One of the sons of James and Jane Bristow, was the Very Rev. John Bristow, Dean of Connor and Rector of St. James's, Belfast, and his son, Mr. John Bristow, is the subject of this memoir.

GRACE DEANE.

W. H. F. PATTERSON.

RESOLUTION PASSED BY THE COUNCIL, 20th MARCH, 1947.

"The Council of the Belfast Natural History and Philosophical Society at this first meeting assembled since the death of William Hugh Ferrar Patterson on the 21st February last, desire to place on record our great regret. His family has been connected with the Society since it was established in 1821. Mr. Patterson was a grandson of Robert Patterson, F.R.S., a Foundation Member; and was the second son of W. H. Patterson, M.R.I.A., who was Honorary Secretary from 1884-1885 and President from 1885-1886. He himself was Honorary Treasurer from 1899-1904. He enjoyed a considerable local reputation as a Writer of Verse, his best known work being *Songs of a Poet* 1920, he was a Director of the old established firm of Robert Patterson & Sons formerly of Bridge Street and now situated in Ann Street."

THE ACCOUNT OF BELFAST NATURAL HISTORY AND PHILOSOPHICAL SOCIETY

For the Year ended 31st October, 1947.

RECEIPTS.

To Balance as per last Account	... £152 3 4
" Subscriptions	... 58 17 0
" Dividends	... 18 6 0
" Rents	... 399 2 0
" Rebate of Income Tax	... 21 12 0
" Miscellaneous Receipts, viz. :—	
Sale of Periodicals	... 1 1 0

4½% York St. Debenture Stock ... £400 0 0
3½% War Stock ... 239 19 0

PAYMENTS.

By Maintenance of Premises, etc.	... £251 0 1
" Rent, Rates and Taxes	... 96 9 0
" Insurance	... 15 3 6
" Salaries and Wages	... 33 17 4
" Lectures	... 67 17 5
" Fuel and Light	... 71 1 7
" Other Payments, viz. :—	
Printing Proceedings	£69 9 5
Postages and Stationery	23 12 10
Expenses, Annual Meeting	2 11 3
Irish Naturalists' Journal (2 years)	6 16 0
Telephone	7 11 4
Cleaning Materials	1 14 2
Bank Charges	1 1 0
Audit Fee	1 1 0
Commission on Rents	14 19 3
Grant to Queen's University Centenary	
Endowment Fund	25 0 0
Expenditure, Archaeological Section	46 13 9
	300 10 0

Balance, per Bank Book	£21 2 5
Balance in Accounting Officer's hands	—
Net Balance	£21 2 5

" Balance in favour of Account on 31st October, 1947 21 2 5

£651 1 4

£651 1 4

We certify that the above is a true Account.

J. CRAWFORD SHAW, Accounting Officer.
F. J. COLE, Governor.

4th day of November, 1947.

I certify that the foregoing Account is correct.

P. C. DUGGAN, Comptroller and Auditor-General.

12th day of January, 1948.

IN ACCOUNT WITH ARCHAEOLOGICAL SECTION, 1946-47.

To Balance 31st October, 1946	...	£46 8 11	By Lecture : Dr. Bersu—Fee	...	£5 0 0
" Subscriptions : Season 1946/47	...	£11 0 0	" " —Expenses	...	5 15 0
" Subsidy : Season 1946/47	...	5 5 0	" " Lantern Hire	...	2 2 0
			" " Oliver Davies—Fee	...	Nil
		16 5 0	" " Lantern Hire	...	2 2 0
			" " Dr. James Scott : Expenses	...	0 18 2
			" " Northern Whig : Printing and Stationery	...	3 10 4
			" " Advertising Lectures	...	6 6 3
			" " Grant to Dr. G. Bersu re Lissue	...	20 0 0
			" " Prof. Evans—Expenses	...	1 0 0
			" " Charge for Rent, Salaries and Overhead	...	12 0 0
			Expenses	...	£58 13 9
			" Balance due to Archaeological Section at 31st		
			October, 1947	...	4 0 2
		£62 13 11			£62 13 11

Certified correct.

J CRAWFORD SHAW,
Hon. Treasurer.

20th November, 1947.

EXCHANGES.

*Publications received during year.

- ABO—Publications of the Abo Academy.
 ADDIS ABABA—Bollettini di Idrobiologia, Caccia e Pesca della Africa Orientale Italiana.
 *ALBANY—Bulletins of the New York State Museum.
 *ANN ARBOR—Publications of the University of Michigan.
 ATHENS—Publications of the Zoological Institute and Museum.
 AUCKLAND—Reports of the Auckland Institute and Museum.
 BASEL—Verhandlungen der Naturforschenden Gessellschaft in Basel.
 BERGEN—Publications of the Bergen Museum.
 BERKELEY, CAL.—Publications of the University of California.
 BERLIN—Publications of the Zoological Museum of Berlin University.
 BIRMINGHAM—Publications of the Birmingham Natural History and Philosophical Society.
 *BLOEMFONTEIN—Publications of the National Museum of South Africa.
 BOSTON—Publications of the Boston Society of Natural History.
 *BOULDER—Publications of the University of Colorado.
 BRIGHTON—Report of the Brighton and Hove Natural History and Philosophical Society.
 BRISBANE—Memoirs of the Queensland Museum.
 *BRUSSELS—Annals Societe Royale Zoologique de Belgique.
 „ Bulletin Societe Royale de Botanique de Belgique.
 BUENOS AIRES—Anales del Museo Argentino de Ciencias Naturales.
 BUFFALO—Bulletins of the Buffalo Society of Natural Sciences.
 CALCUTTA—Publications of the Geological Survey of India.
 *CAMBRIDGE, MASS.—Publications of the Museum of Comparative Zoology.
 CARDIFF—Transactions of the Cardiff Naturalists' Society.
 CHICAGO—Publications of the Chicago Academy of Sciences.
 CINCINNATI—Publications of the Lloyd Library and Museum.
 COIMBRA—Publications of the Zoological Museum of the University of Coimbra.
 COLORADO SPRINGS—Publications of the Colorado College.
 COLUMBIA—Proceedings of the Missouri Academy of Science.
 COLUMBUS—Ohio Journal of Science.
 „ Bulletin of the Ohio Biological Survey.
 COVENTRY—Proceedings of the Coventry Natural History and Scientific Society.
 DANZIG—Schriften Naturforschenden Gesellschaft.
 DUBLIN—Proceedings of the Royal Dublin Society.
 „ „ Irish Historical Studies.”
 „ Bulletin of Geographical Society of Ireland.
 EASTBOURNE—Transactions and Journal of the Eastbourne Natural History and Archaeological Society.
 EDINBURGH—Proceedings of the Royal Physical Society.
 „ „ Proceedings of the Royal Society of Edinburgh.
 * „ „ Transactions and Proceedings of the Botanical Society of Edinburgh.
 „ „ Proceedings of the Society of Antiquaries of Scotland.
 EXETER—Proceedings of the Devon Archaeological Exploration Society.
 GLASGOW—Transactions of the Geological Society of Glasgow.

- GORLITZ—Publications of the Natural History Society of Gorlitz.
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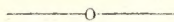
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